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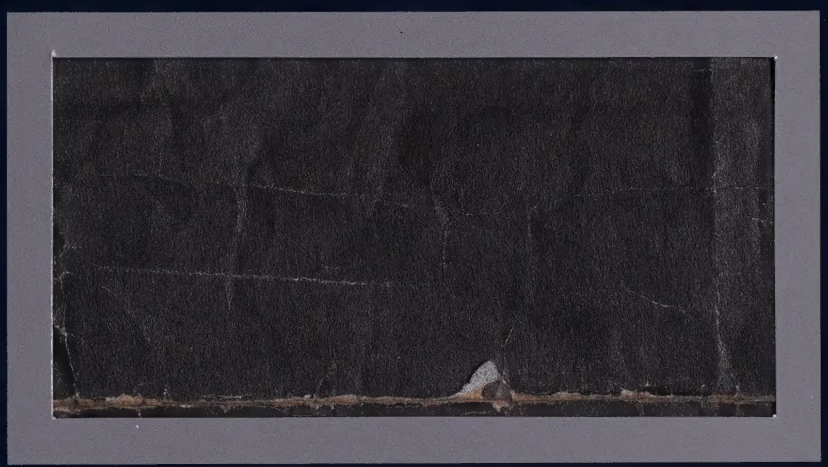

Operating Manual

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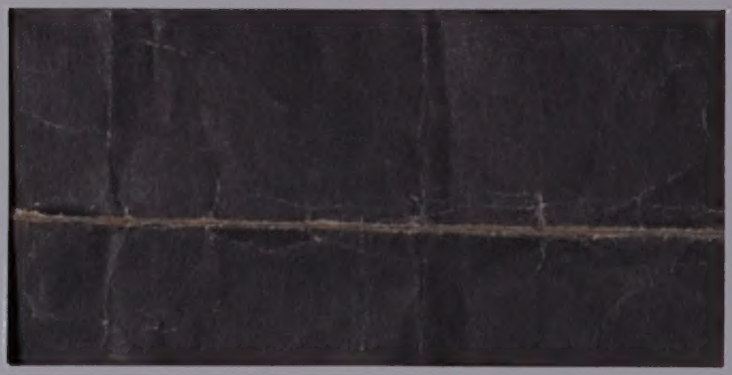

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CCITT 2.048M/Nx64K DATA INTERFACE (MODEL 41800) OPERATING MANUAL

DECEMBER 1993

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SECTION 1
GENERAL INFORMATION

1.1 INTRODUCTION

This manual contains information describing the Telecommunications Techniques Corporation 2.048M/Nx64K Data Interface Adaptor (Model 41800). This information is divided into the following sections: general information, interface description, installation and set-up, mainframe set-up, interface specifications, and service information.

The 2.048M/Nx64K Data Interface allows the FIREBERD mainframe to test communications equipment and systems that comply with CCITT G.703, G.704, G.732, 2048 kbps, and Nx64 kbps signal recommendations for framed or unframed data.

The 2.048M/Nx64K Data Interface allows any selection of Nx64 kbps timeslots within the 2.048 Mbps signal to be accessed for bit error analysis. This allows real-time analysis of any number of timeslots (up to 30 or 31, depending on the selected multiframing).

1.2 INTERFACE FEATURES

The 2.048M/Nx64K Data Interface has the following features:

- Unframed or framed 2048 kbps signal analysis with TS-16 CAS (Channel Associated Signalling) and/or CRC4 multiframing.
- Nx64 kbps or Nx56 kbps analysis with unrestricted timeslot selection.
- Nx64 insert mode.
- Round-trip delay[1] measurement.
- Frequency measurement.
- Timing Slips and Wander[1] measurements.
- Jitter[2] measurements.
- Positive and negative base-to-peak digital signal level measurements, in dB.
- In-service monitoring.
- G.821 performance analysis.
- Four selectable transmitter timing sources.
- Programmable timeslot and ABCD IDLE codes.
- Selectable MSB or LSB stuffing in Nx56 kbps analysis mode.
- Selectable voice coding: A-Law or μ-Law.
- Single or consecutive FAS Word error insertion.

- Logic and/or code error insertion (single or variable rate).
- AMI or HDB3 coding.
- Test loopback.
- Voice mode through a telephone handset.
- ABCD signalling access with CAS multiframing.
- Selectable input termination, including MONITOR mode.
- Output line build-out level selection.
- Display Frame Alignment Signal, Not Frame Alignment Signal, Multiframe Alignment Signal, and Receive Byte of selected timeslot.
- Transmit alarms.
- Programmable TS0 national bits, international bits, and TS-16 spare bits.
- Broadcast mode.
- 2Mbps alarm detection.

[1] FIREBERD 6000 only.

[2] FIREBERD 6000 with Jitter option installed.

1.3 INTERFACE COMPATIBILITY

The 2.048M/Nx64K Data Interface is designed in accordance with and meets the applicable sections of the following recommendations.

- G.703
- G.704
- G.732
- G.821
- G.823
- O.171
- O.161

NOTE: The FIREBERD 2^{20}-1 pattern follows the North American Specification and is not compatible with the 2^{20}-1 pattern specified in CCITT Recommendation V.57.

1.4 OPTIONS AND ACCESSORIES

The following cables and accessories are available from TTC for use with the Model 41800 2.048M/Nx64K Data Interface.

- Model 30662 BNC to BNC cable (2.0m).
- Model 30687 Siemens 3-pin connector to Siemens 3-pin connector.
- Model 30761 Siemens 3-pin connector to bantam plug (2.0m).
- Model 31066 BNC (75Ω Unbalanced) connector to Siemens 3-pin connector (120Ω Balanced) adaptor (2.0m).

SECTION 2
INTERFACE DESCRIPTION

2.1 INTRODUCTION

This section contains a physical and functional description of the 2.048M/Nx64K Data Interface, its capabilities, and features.

2.2 PHYSICAL DESCRIPTION

The 2.048M/Nx64K Data Interface Adaptor (Model 41800) plugs into the FIREBERD mainframe interface slot. The FIREBERD mainframe connector provides the supply voltages to the interface module. Two thumbscrews secure the interface into the FIREBERD mainframe. Six connectors, on the interface module front panel, allow connection to the circuit under test. These connectors include: one RJ8 (4-pin) connector, two banana connectors, and three BNC connectors. A 4-segment DIP switch, located inside the protective plastic cover, determines the line coding (AMI or HDB3), the Nx56 kbps bit order (MSB or LSB), and the voice coding (μ-Law or A-Law). When viewing the interface front panel, the DIP switch (S1) is located on the right side of the interface assembly. The switch segment setting and function selected is listed in Table 2-1. The default setting is: segments 1, 2, and 3 closed.

Table 2-1
DIP Switch S1 Setting and Selection

Segment	Setting	Open	Closed
1	Code Selection	AMI	HDB3
2	Nx56k Format	MSB=1 (1+7)	LSB=1 (7+1)
3	Voice Coding	μ-Law	A-Law
4	Unused		

Figure 2-1 illustrates the 2.048M/Nx64K Data Interface front panel.

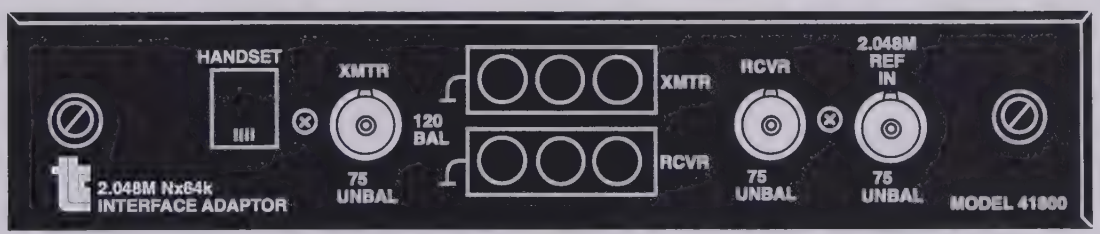

Figure 2-1
2.048M/Nx64K Data Interface

2.2.1 HANDSET

The RJ8 connector is used to attach a handset to the HANDSET connector. A standard telephone handset is used to drop and insert a voice channel. Figure 2-2 illustrates the HANDSET connector. Table 2-2 lists the RJ8 connector pin assignments.

Figure 2-2
HANDSET Connector

Table 2-2
RJ8 Connector Pin Assignments

Pin	Function
1	Microphone +
2	Speaker +
3	Speaker -
4	Microphone -

2.2.2 2.048M REF IN

This BNC connector accepts a bipolar (AMI- or HDB3-encoded) framed or unframed 2048 kbps reference signal from an external source. This reference signal is used for timing slips, wander measurements, and can be used as a transmit timing source. The input impedance for this connector is 75 ohms. The signal at this connector can be used as the generator clock source when GEN CLK is set to INTF and the IF CLK menu item is set to REF.

2.2.3 120 Ω BAL RCVR

This banana connector is used when connecting to balanced circuits. This connector provides a 120-ohm load impedance to the received signal when INPUT is set to TERM or MON. When INPUT is set to BRDG, the input impedance is greater than 1KΩ.

2.2.4 120 Ω BAL XMTR

This banana connector is used when connecting to balanced circuits. This connector provides a 120-ohm source impedance to the transmitted signal.

2.2.5 XMTR 75 Ω UNBAL

This BNC connector is used when connecting to unbalanced circuits. This connector provides a 75-ohm source impedance to the transmitted signal.

2.2.6 RCVR 75 Ω UNBAL

This BNC connector is used when connecting to unbalanced circuits. This connector provides a 75-ohm load impedance to the received signal when INPUT is set to TERM or MON. When INPUT is set to BRDG, the input impedance is greater than 1KΩ.

NOTE: The 75Ω and 120Ω inputs (RCVR) are connected together internally. Thus, only one connector type should be used at any time.

2.3 FUNCTIONAL DESCRIPTION

The Data Interface provides the FIREBERD Communications Analyzer with the ability to test in one of the following modes of operation:

FULL2M - Full 2048 kbps BERT
Nx64k - Nx64 kbps BERT†
N64INS - Nx64 kbps Insert†
VOICE - Voice†
BRDCST - Broadcast†
TLB - Test loopback

The following paragraphs provide additional information about each mode of operation.

2.3.1 FULL 2M

In FULL2M mode, the 2.048M/Nx64K Data Interface provides access to the entire 2048 kbps signal (2048 kbps for unframed operation, 1984 kbps for framed operation, or 1920 kbps for framed with TS16 set to ON), allowing the FIREBERD to analyze the signal. This mode allows the entire 2M bandwidth to be tested.

2.3.2 Nx64k[1]

In Nx64k mode, any number of transmit or receive timeslots can be selected for Nx64 kbps or Nx56 kbps BERT analysis. This allows individual timeslots or groups of timeslots to be tested. The timeslots that are not used for BERT are filled with a selectable 8-bit idle code.

2.3.3 N64INS[1]

In Nx64k insert mode, the setup is identical to the Nx64k mode, except the unused timeslots are filled with received data in the same timeslots (instead of the 8-bit idle code). This mode allows the FIREBERD to perform Nx64 kbps BERT analysis from a 2 Mbps access point without disrupting live traffic on the entire 2 Mbps bandwidth. This mode is not valid with SELF LOOP on.

2.3.4 VOICE[1]

In Voice mode, one timeslot is selected for monitoring, or separate timeslots selected for talk and listen. The selected timeslot contains the information from the handset. The signalling bits can be monitored in the RESULTS display window. If the selected timeslot transmission is enabled, the ABCD signalling bits can be changed. To enable ABCD signalling, TS16 must not be set OFF.

2.3.5 BRDCST[1]

In Broadcast mode, the entire selected test pattern is inserted into each timeslot and repeated either 30 times (if TS16 is On) or 31 times (if TS16 is Off) for Nx64k mode only. The first 8 bits are inserted in timeslot 1, the first 8 bits into timeslot 2, etc. until the entire pattern is transmitted. One timeslot must be specified to receive the transmitted pattern*.

2.3.6 TLB

In TLB (test loopback) mode, the full received 2048 kbps is looped back to the transmit output. At the receive input, analysis is performed on all the timeslots (similar to FULL 2M). The data is re-clocked and code errors are corrected before retransmission. TLB mode is not valid when SELF LOOP is on.

2.4 SELF-LOOP OPERATION

Pressing the SELF LOOP switch, located on the FIREBERD front panel, enables the mainframe self-loop mode. The self-loop mode internally loops the 2.048M/Nx64K Data Interface output to its input. This provides the ability to verify the operation of the FIREBERD mainframe and the 2.048M/Nx64K Data Interface. Any cables attached to the interface do not have to be disconnected, since the interface connectors are electronically isolated during self-loop operation.

NOTE: If the 2.048M/Nx64K Interface is set to perform Nx64k BERT on different receive and transmit timeslots, the FIREBERD cannot attain pattern synchronization in SELF LOOP.

† Requires FRAMED operation to be selected to prevent the message **Current mode requires framing** from being flashed in the results display.

[1] The GEN FREQ and RCVR FREQ results displayed in these modes are the data bit rates, not the line rates (e.g., 1x64k = 64 000; 2x64k = 128 000).

* 1x64 kbps BERT analysis is performed in this selected receive timeslot.

SECTION 3
INSTALLATION AND OPERATION

3.1 INTRODUCTION

This section describes how to install, setup, and operate the FIREBERD mainframe with the 2.048M/Nx64K Data Interface. Whether installed in a FIREBERD 6000 or a FIREBERD 4000, the 2.048M/Nx64K Data Interface operation is essentially the same. Refer to the appropriate FIREBERD Reference Manual or User's Guide for additional information concerning FIREBERD mainframe switch functions and operating parameters.

Where only minor differences in operation or function occur, one description or discussion is provided for both mainframes (e.g., installation, results, remote control commands, and interface testing) and the differences are noted. However, where major differences occur (e.g., interface menus and menu choices), a separate discussion is provided for the FIREBERD 6000 and FIREBERD 4000.

3.2 INTERFACE INSTALLATION

Perform the following steps to install the 2.048M/Nx64K Data Interface in the FIREBERD mainframe.

1. Turn the FIREBERD mainframe AC power OFF.

2. Turn the FIREBERD mainframe around to view the rear panel to observe the interface slot. If the interface slot is vacant, proceed to step 5. If the interface slot has an interface installed in it, proceed with the following step.

3. Turn the two thumbscrews counterclockwise until the screw is fully removed from the mainframe (spring tension is removed from the screw).

4. Remove the interface module from the mainframe by gripping the thumbscrews and gently pulling the module straight out.

5. Insert the interface module into the vacant interface slot (two interface slots are available in FIREBERD 4000 mainframes with Option 4001 installed). The printed circuit board is inserted into slots located at the top of the interface slot.

6. Apply firm but even pressure to securely seat the interface module. The module is properly seated when the back of the interface is flush with the mainframe rear panel.

7. Turn the two interface module thumbscrews clockwise to secure the interface in the mainframe.

This completes the interface installation. The mainframe is ready now to be configured for the test to be performed. To prevent circuit downtime, it is recommended to configure the mainframe and interface before connecting cables from the interface to the circuit under test.

3.3 FIREBERD MAINFRAME CONFIGURATION

The type of FIREBERD mainframe (6000 or 4000) into which the 2.048M/Nx64K Data Interface is installed determines the mainframe configuration procedure. Since the configuration procedure is different for each mainframe, refer to Table 3-1 to determine the mainframe configuration for the type of FIREBERD mainframe that you are using.

NOTE: In order to generate accurate error insertion rates, the FIREBERD frequency synthesizer must be set to 2.048 kHz, even if the synthesizer is not used as the source of transmit timing.

Table 3-1
FIREBERD Mainframe Configuration

Switch/ Selection	FIREBERD 6000	FIREBERD 4000
POWER	ON	ON
SELF LOOP	OFF	OFF
GEN CLK GENERATOR CLOCK	SYNTH — — —	— — — SYNTH
INTF SETUP INTERFACE	2M/n64 — — —	— — — 2M/n64
ANALYSIS MODE	CONTINUOUS	N/A
PRINTER	OFF	OFF
DISPLAY HOLD	OFF	OFF

NOTE: — — — indicates that this selection is not available for the mainframe being used.

Depending on the test to be performed, additional mainframe settings (e.g., DATA/PATTERN, AUXILIARY selections, and RESULTS) may also need to be set before performing a test.

3.4 2.048M/NX64K INTERFACE MENU IN A FIREBERD 6000

The 2.048M/Nx64K Data Interface menu is illustrated in Figure 3-1 and explained in the following paragraphs. From the INTERFACE selection menu, pressing the softkey below the 2M/n64 menu item selects it as the active interface. With the 2.048M/Nx64K Data Interface selected, the first three menu items (CONFIG, MODE, and ERRINS) are displayed on the bottom line of the left display window and the LED in the MORE switch illuminates. Pressing the MORE switch displays three additional menu item selections (IDLE, RCVBYT, and ALARMS). Pressing the MORE switch once more displays the last menu item (FRWORD). Pressing the MORE switch again re-displays the first three menu items (CONFIG, MODE, and ERRINS). Pressing the softkey below a displayed menu item displays the corresponding menu or selects that parameter as the active parameter value.

Table 3-2 lists the top level interface menu choices and a brief description of the function each performs. The paragraphs following Table 3-2 describe the top level menu selections in greater detail and describe the additional menu item selections available.

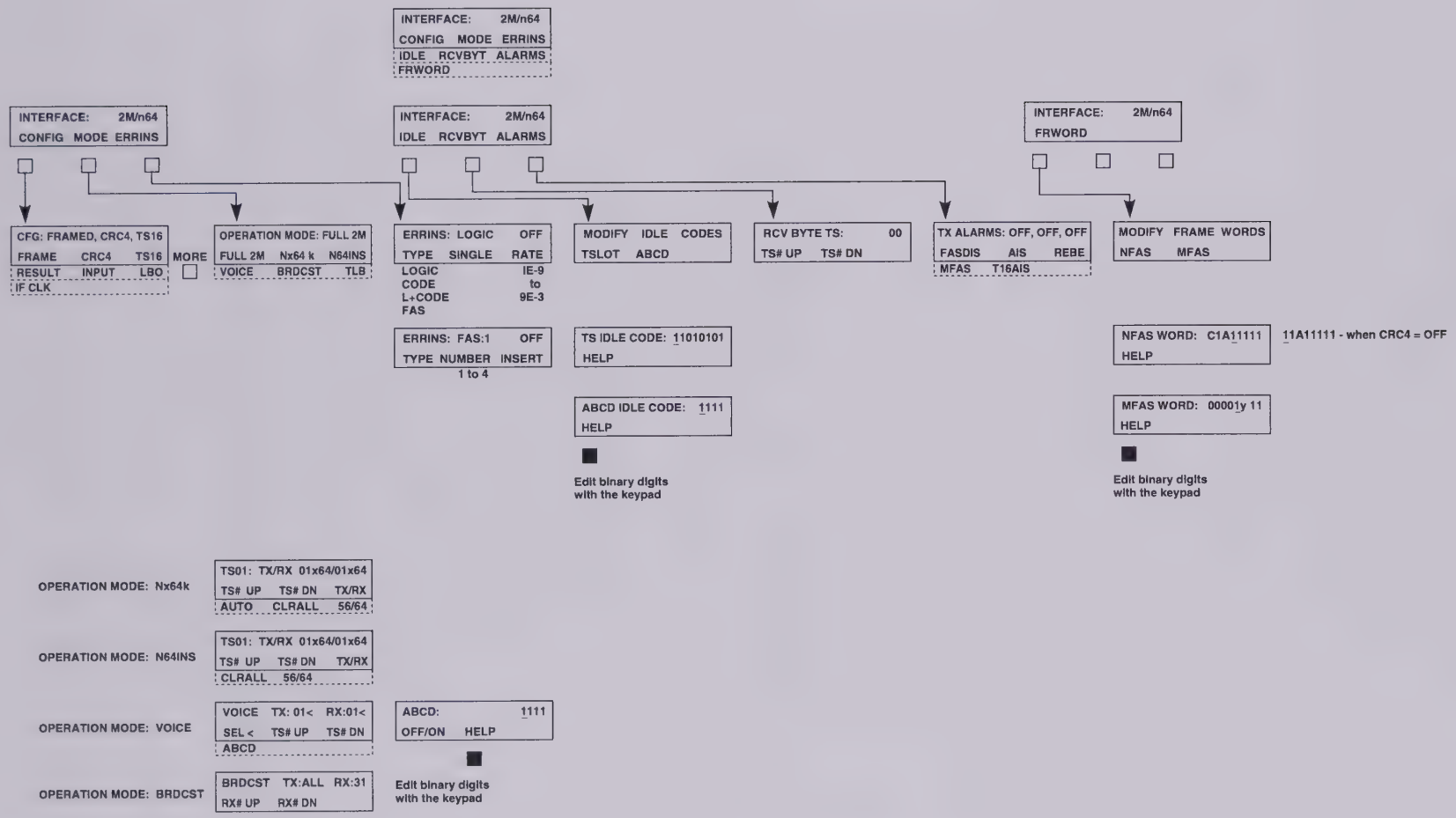

Figure 3-1
2.048M/NX64K Interface Menu for the FIREBERD 6000

Table 3-2
FIREBERD 6000 Top Level 2.048M/Nx64K Interface Menu Choices

Menu Item	Selection
CONFIG	Selects the data framing format (UNFRAM or FRAMED), CRC4 (OFF or CRC4), TS16 (OFF or TS16), result (STD or LIVE), input termination (TERM, BRDG, or MON), line build-out (0dB, -6dB, -12dB, or MON), and interface transmit clock source (RCVR or REF).
MODE	Selects the operation mode (FULL2M, Nx64k, N64INS, VOICE, BRDCST, or TLB).
ERRINS	Selects the error insertion type (LOGIC, CODE, L+CODE, or FAS) and the number of errors inserted (OFF, SINGLE, or RATE).
IDLE	Selects the idle code 8-bit byte inserted on unselected timeslots and the ABCD idle code, if TS16 is set on.
RCVBYT	Selects timeslot for the RX BYTE (Received Byte) result.
ALARMS	Selects the transmit alarm status for FASDIS (FAS Distant), AIS (Alarm Indication Signal), REBE (Remote End Block Error), MFAS (MFAS Distant), and T16AIS (Timeslot 16 Alarm Indication Signal).
FRWORD	Selects the NFAS and MFAS frame word bytes.

3.4.1 CONFIG

CONFIG - pressing the softkey below the CONFIG menu item displays the status of the first three configuration menu selections (FRAME, CRC4, and TS16) on the top line of the display. Pressing the MORE softkey displays the next three menu items (RESULT, INPUT, and LBO). Pressing the MORE softkey once more displays the final menu item (IF CLK). Pressing the MORE softkey once more redisplays the first three menu items. Pressing the softkey below the menu items displayed on the bottom line toggles the corresponding selection from its displayed status to its other choice. The configuration menu choices are displayed in Figure 3-2. Menu item choices and ranges are described in the following paragraphs.

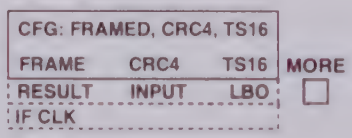

Figure 3-2
Configuration Menu and Menu Items

1. **FRAME** - selects the 2Mbps framing format. Framing choices are: FRAMED or UNFRAM. Pressing the softkey below this menu item toggles the frame status from FRAMED to UNFRAM.

   FRAMED - selects the framed format for use with all operating modes. If this menu selection is set to UNFRAM and the selected mode requires framing, the message **Current mode requires framing** is flashed in the results display accompanied by an audible beep.

   UNFRAM - selects the unframed format for use with FULL2M and TLB operating modes.

2. **CRC4** - selects use of the timeslot 0 Si bits for CRC multiframing. When set to CRC4, the Si bits are used for CRC4 information. When set to OFF, the Si bit is set to 1. (This bit is selectable in the NFAS WORD menu.) If the FRAME menu item is set to UNFRAM, the CRC status selection is displayed as — — — and cannot be changed.

3. **TS16** - selects the use of timeslot 16 for TS-16 multiframing. When set to TS16, timeslot 16 is reserved for use of the ABCD signalling bits. If timeslot 16 has already been configured for use (e.g., configured as TX/RX in the Nx64 mode or as the RX timeslot in BRDCST mode), the previous configuration is overridden and accompanied by the message **Timeslot 16 was in use** is displayed in the results window accompanied by an audible beep. When TS16 is set to OFF, normal data can be inserted in timeslot 16. If the FRAME menu item is set to UNFRAM, the TS16 menu item is displayed as — — — and cannot be changed.

4. **RESULT** - selects the criteria required to support results analysis. Results analysis choices are: STD or LIVE.

   STD - selects results:tandard results. STD is used for out-of-service bit error analysis. All counting results are only counted during pattern synchronization, unless Auxiliary Function 03 (ACT SYN LOSS) is set to CONT. The G.821 results are based on bit errors and pattern synchronization bits. The bit test intervals are conducted over pattern bits.

   LIVE - selects live analysis. LIVE is used for in-service monitoring. Initial frame synchronization is required before frame-synchronization dependent counting results become ready. All other counting results become ready on initial signal detection. G.821 results are based on code errors and total bits; and bit test intervals are over total bits.

5. **INPUT** - selects the interface input impedance characteristics. Input choices are: TERM, BRDG, and MON.

   TERM - connects the 75Ω or 120Ω termination resistor for the interface cable connection. This selection allows the interface to properly terminate an unterminated circuit.

   BRDG - provides >1KΩ input termination for the interface cable connection. This allows the interface to be connected to a properly terminated circuit without disrupting traffic by loading the line.

   MON - connects the 75Ω or 120Ω termination resistor and adds up to 30 dB of gain to compensate for the resistive loss encountered at resistively isolated 2Mbps monitor access points. This allows the interface to be connected to a properly terminated circuit at the resistively isolated 2Mbps monitor access point.

6. **LBO** - selects the line build-out characteristics. Line build-out choices are: 0dB, -6dB, -12dB, and MON.

   0dB - simulates 0 dB of cable loss.

   -6dB - simulates passing the signal through enough cable to produce 6 dB of cable loss.

   -12dB - simulates passing the signal through enough cable to produce 12 dB of cable loss.

   MON - Simulates passing the signal through 30 dB of pure resistive attenuation, which would be found at a resistively isolated monitor point.

7. **IF CLK** - selects interface generator clock transmit timing source. This selection only affects the transmit clock when GEN CLK is set to INTF (on the FIREBERD 6000 front panel). Interface clock choices include: RCVR and REF.

   RCVR - selects the transmit timing clock source recovered from the received data.

   REF - selects the signal at the interface BNC connector labeled 2.048M REF IN as the reference for the transmit timing source. Note that with REF selected, some residual jitter (up to 0.17UI) may be added to the transmitted signal.

3.4.2 MODE

MODE - pressing the softkey below the MODE menu item displays the first three operating mode menu selections (FULL2M, Nx64k, and N64INS) on the top line of the display. Pressing the MORE softkey displays the next three menu items (VOICE, BRDCST, and TLB). Pressing the MORE softkey once more redisplays the first three menu items. Pressing the softkey below

the menu items displayed on the bottom line displays the corresponding mode selection menu. The mode menu choices are displayed in Figure 3-3. MODE menu choices are: FULL2M, Nx64k, N64INS, VOICE, BRDCST, and TLB. The following paragraphs describe the menu choices for the menu item choices.

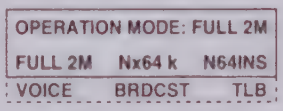

Figure 3-3
Operating Mode Menus and Available Selections

1. **FULL2M** - selects the full 2.048 Mbps operating mode. This mode is selected to analyze the full 2.048M bandwidth.

   In FULL2M mode, the 2.048M/Nx64K Data Interface provides access to the entire 2048 kbps signal (2048 kbps for unframed operation, 1984 kbps for framed operation, or 1920 kbps for framed with TS16 set to ON), allowing the FIREBERD to analyze the signal. This mode allows the entire 2M bandwidth to be tested.

2. **Nx64k** - selects the Nx64k or Nx56k bit error analysis operating mode and displays its corresponding menu. Nx64k operation allows the user to perform bit error analysis on any combination of selected timeslots and select the desired timeslot(s) for testing. The top line of this menu displays the timeslot number (01 to 31), the timeslot status (TX/RX), and an indication of the total number of timeslots enabled for bit error analysis (in 64k or 56k increments). The softkeys below the first three menu items (TS# UP, TS# DN, and TX/RX) are used to scroll through the timeslots and to select the displayed timeslot status (TX/RX, TX/- -, - -/RX, or - -/- -). Pressing the MORE softkey displays the next three menu items (AUTO, CLRALL, and 56/64). Pressing the MORE softkey again displays the first three Nx64k menu items.

   In Nx64k mode, any number of transmit or receive timeslots can be selected. This allows individual timeslots or groups of timeslots to be tested.

   TS# UP - pressing the softkey below this menu item scrolls up through the available timeslots. Each time the TS# UP softkey is pressed, the TX/RX selection is blanked (set to - -/- -). When scrolling up, if TS16 (from the CONFIG menu) is enabled, the displayed timeslots increment from 15 to 17. Timeslot 16 is not displayed. Note that the keypad keys can also be used to select the desired timeslot. However, if the keypad keys are used to enter timeslot 16 and TS16 is set On, the message **Timeslot 16 is set for ABCD signalling** is flashed in the results window and an audible tone is generated. The timeslot selection then defaults to 15.

   TS# DN - pressing the softkey below this menu item scrolls down through the available timeslots. Each time the TS# UP softkey is pressed, the TX/RX selection is blanked (set to - -/- -). When scrolling down, if TS16 (from the CONFIG menu) is enabled, the displayed timeslots decrements from 17 to 15. Timeslot 16 is not displayed. Note that the keypad keys can also be used to select the desired timeslot. However, if the keypad keys are used to enter timeslot 16 and TS16 is set On, the message **Timeslot 16 is set for ABCD signalling** is flashed in the results window and an audible tone is generated. The timeslot selection then defaults to 15.

   TX/RX - selects displayed the timeslot transmit and receive status. Repeatedly pressing the softkey below this menu item scrolls through the timeslot transmit/receive selections for the displayed timeslot. The TX/RX menu item choices are: TX/RX, TX/- -, - -/RX, or - -/- -.

   TX/RX transmits and receives on the displayed timeslot.
   TX/- - only transmits on the displayed timeslot.
   - -/RX only receives on the displayed timeslot.
   - -/- - sets the displayed timeslot to idle.

   Inactive timeslots are filled with the 8-bit timeslot idle code (selectable from the IDLE menu).

AUTO - initiates a scan of the timeslots on the received signal. Each non-idle timeslot detected is set to TX/RX. This automatically configures the FIREBERD to the active timeslots on the Nx64 kbps signal.

CLRALL - resets all timeslots to - -/- -.

56/64 - selects the timeslot data rate for Nx64 kbps or Nx56 kbps analysis. Pressing the softkey below this menu item toggles the displayed data rate between 56 kbps and 64 kbps. When 64 kbps is selected, Nx64k analysis is performed. When 56 kbps is selected, Nx56k analysis is performed. The segment 2 setting of the DIP switch determines the position of the unused bit of each 56 kbps timeslot. Setting this segment to OPEN selects the MSB (1+7) as the unused bit and when set to CLOSED, the LSB (7+1) is selected as the unused bit.

3. **N64INS** - selects the Nx64 kbps insert operating mode, which allows the user to insert a BERT pattern on any combination of selected Nx64 kbps timeslots without disrupting traffic on the remaining timeslots. N64INS operation allows the user to select the desired timeslot(s) for testing. The key difference from Nx64k operation is that in N64INS operation, the unused timeslots at the output of the FIREBERD are filled with data received in that timeslot. Refer to the preceding Nx64k menu item descriptions for an explanation of the N64INS menu items.

   In Nx64k insert mode, the setup is identical to the Nx64k mode, except the unused timeslots are filled with received data in the same timeslots (instead of the 8-bit idle code). When the TS16 menu item is enabled, timeslot 16 is considered unused. Thus the output of this timeslot is filled with received data. This mode is not valid with SELF LOOP on.

4. **VOICE** - selects the voice operating mode and displays its corresponding menu. Voice mode is independent of the RESULT (STD or LIVE) selection. Voice is always in live mode, regardless of the RESULT menu selection. Voice operation allows the user to select the A-Law or μ-Law encoded transmit and receive timeslot(s), and to set the ABCD signalling bits for the selected transmit timeslot. The voice encoding is selected by segment 3 of the DIP switch. In the OPEN position, μ-Law encoding is selected and in the CLOSED position, A-Law encoding is selected. To enable ABCD signalling, the TS16 menu item must not be set OFF.

   In the voice mode, one timeslot is selected for monitoring, or separate timeslots selected for talk and listen. The selected transmit timeslot contains the PCM A-Law or μ-Law encoded information from the handset. The received signalling bits can be monitored via the ANALYSIS RESULTS section on the FIREBERD front panel. If the selected timeslot transmission is enabled, the ABCD signalling bits can be changed if set to ON.

   The first three menu items (SEL<, TS# UP, and TS# DN) are visible on the bottom line. Pressing the MORE softkey displays the last menu item (ABCD). Pressing the MORE softkey again redisplays the first three menu items. These menu items are described in the following paragraphs.

   SEL< - selects the whether the TX and/or RX timeslot is selected for modification with the TS# UP and TS# DN softkeys. Pressing the softkey below this menu item toggles the TX or RX menu item selection as follows:

   TX:01< RX:01< - the TX and RX timeslots are changed by the TS# UP or TS# DN key
   TX:01 RX:01< - only the RX timeslot is affected by the TS# UP or TS# DN key
   TX:01< RX:01 - only the TX timeslot is affected by the TS# UP or TS# DN key

   The < indicates that the associated timeslot (TX or RX) is selected.

   TS# UP - pressing the softkey below this menu item scrolls up through the available timeslots. When scrolling up, if TS16 (from the CONFIG menu) is enabled, the displayed timeslots increments from 15 to 17 and skips 16. Note that the keypad keys can also be used to select the desired timeslot. However, if the keypad keys are used to enter timeslot 16 and TS16 is set On, the message **Timeslot 16 is set for ABCD signalling** is flashed in the results window and an audible tone is generated and the timeslot selection defaults to 15.

   TS# DN - pressing the softkey below this menu item scrolls down through the available timeslots. When scrolling down, if TS16 (from the CONFIG menu) is enabled, the displayed timeslots decrements from 17 to 15 and skips 16. Note that the keypad keys can also be used to select the desired timeslot. However, if the keypad keys are used to enter timeslot 16 and TS16 is set On, the message **Timeslot 16 is set for ABCD signalling** is flashed in the results window and an audible tone is generated and the timeslot selection defaults to 15.

ABCD - pressing the softkey below this menu item displays the ABCD signalling bit binary status. The TS16 menu item must be set ON and the VOICE operating mode selected to use the ABCD signalling bits. Pressing the softkey below the ON/OFF menu item selects either the programmable idle ABCD code or a user-programmable ABCD code to be transmitted in the selected timeslot. The left-arrow key and right-arrow key can be used to change the cursor position. After changing the status of any signalling bit, press the ENTER switch to save the new signalling bit value. Note that if the ENTER switch is not pressed after changing the signalling bit value, after exiting this menu, the signalling bit value is returned to the last saved value. If the VOICE mode is not selected and TS16 set to ON, the signalling bits can only be viewed.

HELP - pressing the softkey below this menu item displays a help message for the signalling bit selection. This message is: **Edit binary digits with the keypad.**

5. **BRDCST** - selects the broadcast operating mode. Pressing the softkey below the BRDCST menu item displays the broadcast menu. The top line displays the selected receive timeslot. The softkeys below the RX#UP and RX#DN menu items, on the bottom line, are used to select the desired receive timeslot (01 to 31) on which to perform BER testing. When scrolling up or down, if TS16 (from the CONFIG menu) is enabled, the displayed timeslots skips timeslot 16. Note that the keypad keys can also be used to select the desired timeslot. However, if the keypad keys are used to enter timeslot 16 and TS16 is set On, the message **Timeslot 16 is set for ABCD signalling** is flashed in the results window and an audible tone is generated and the timeslot selection defaults to 15.

   In broadcast mode, the entire pattern is inserted into each timeslot and repeated either 30 times (if TS16 is On) or 31 times (if TS16 is Off). The first 8 bits are inserted in timeslot 1, the first 8 bits into timeslot 2, etc. until the entire pattern is transmitted. One timeslot must be specified to receive the transmitted pattern.

6. **TLB** - selects the test loopback mode of operation. The TLB operating mode loops back the entire 2048 kbps data stream from the input to the output of the FIREBIRD. Logic error, code error, and jitter injection are possible, however, FAS error insertion is not supported in TLB mode.

   In the TLB mode, the full received 2048 kbps is looped back to the transmit output. At the receive input, analysis is performed on all the timeslots (similar to FULL 2M). The data is re-clocked and code errors are corrected before retransmission. TLB mode is not available when SELF LOOP is on.

3.4.3 ERRINS

ERRINS - selects the error insertion type and number. Pressing the softkey below the ERRINS menu item displays the error insertion menu. The top line indicates the type of error (LOGIC, CODE, L+CODE, or FAS) selected and its current status. The following paragraphs describe the menu choices available for the error insertion menu.

NOTE: When inserting logic errors from the 2M/n64 menu, it is important to understand that not every time the softkey below the SINGLE softkey is pressed that the number of bit errors increases by 1. A logic error may not be detected if the bit error occurs in an idle timeslot, timeslot 16 if TS16 multiframing is on, in the international bit or national bits, or occurs in the FAS word. Using the front panel ERROR INSERT switch always inserts a detected bit error.

1. **TYPE** - pressing the softkey below this menu item scrolls through the error insertion types. Error insertion selections are: LOGIC (bit error), CODE, L+CODE, or FAS (TS0 error). Selecting FAS word error insertion changes the error insertion menu visible in the display window.

2. **FAS** - with FAS error insertion selected, pressing the softkey below the NUMBER menu increments the number of FAS errors from 1 to 4. Pressing the softkey below the INSERT menu item inserts the selected number (1 to 4) on 1 to 4 consecutive FAS words and momentarily flashes that number on the top line of the display. FAS error insertion does not operate in TLB mode, but does operate in all other modes.

3. **SINGLE** - pressing the softkey below this menu item causes a single error of the selected type (LOGIC, CODE, or L+CODE) to be inserted in the transmit data stream and 1 to be flashed in place of OFF on the top line of the display.

4. **RATE** - pressing the softkey below this menu item displays the selected error insertion rate (1E-9 to 9E-3). Pressing the softkey below the HELP menu item displays the message: **Enter error insertion rate: 1E-9 to 9E-3** for several seconds in the display window. Use the keypad keys to enter the desired value and the left and right arrow keys to position the cursor.

3.4.4 IDLE

IDLE - selects the idle code menu. Pressing the softkey below the menu items (TSLOT or ABCD) on the bottom line displays the corresponding idle code menu.

1. **TS IDLE CODE** - this menu displays the timeslot idle code that is transmitted in idle timeslots. The cursor position indicates the bit that is to be modified. Pressing the 0 or 1 key on the keypad sets the binary status at the cursor position to the corresponding value and moves the cursor to the next bit position to the right. The left-arrow key and right-arrow key can be used to change the cursor position. After changing the status of any timeslot idle code bit, press the ENTER switch to save the new idle code bit value. NOTE: If the ENTER switch is not pressed after changing the bit value, after exiting this menu, the idle code binary value is returned to the last saved value.

   HELP - pressing the softkey below this menu item displays a help message for the signalling bit selection. This message is: **Edit binary digits with the keypad.**

2. **ABCD IDLE CODE** - this menu displays the channel idle code that is transmitted in timeslot 16, only if the TS16 menu item is enabled. The cursor position indicates the bit that is to be modified. Pressing the 0 or 1 key on the keypad sets the binary status at the cursor position to the corresponding value and moves the cursor to the next bit position to the right. The left-arrow key and right-arrow key can be used to change the cursor position. After changing the status of any ABCD idle code bit, press the ENTER switch to save the new idle code bit value. NOTE: If the ENTER key is not pressed after changing the bit value, after exiting this menu, the idle code binary value is returned to the last saved value.

   NOTE: An idle code of all 0s is not recommended, since all zeros emulates the TS16 multiframe alignment signal.

   HELP - pressing the softkey below this menu item displays a help message for the signalling bit selection. This message is: **Edit binary digits with the keypad.**

3.4.5 RCVBYT

RCVBYT - selects the timeslot (00-31) to be displayed in the RX BYTE result. Pressing the softkey below the TS# UP or TS# DN menu item increments or decrements the displayed timeslot respectively. The keypad keys can also be used to enter the desired timeslot numerical value.

3.4.6 ALARMS

ALARMS - displays the transmit alarm menu. This menu is used to transmit 2.048M alarms to test 2.048M transmission equipment. The transmit alarm menu displays the status of the transmit alarms on the top line and the corresponding alarm on the bottom line. When the 2.048M/NX64K Interface is first selected, all the transmission alarms default to OFF. Transmission alarm choices are: FASDIS, AIS, REBE, MFAS, and T16AIS. Pressing the softkey below the menu item on the bottom line toggles the alarm condition on the top line. For example, if the top line displays OFF for AIS, pressing the softkey below the AIS menu item toggles the alarm status on the top line from OFF to AIS. The other transmission alarms function in the same way.

Transmitting the various alarms cause the following conditions to occur.

FAS DIS - (FAS Distant) controls the NFAS "A" bit. When OFF, A = 0 and when ON, A = 1.
AIS - (Alarm Indication Signal) sends an unframed "all ones" signal.
REBE - (Remote End Block Error) controls the NFAS "E" bits (Si bits) in frames 13 and 15. When OFF, E = 1 and when ON (REBE), E = 0. When AUTO is selected, "E" normally is set to 1 with a single E bit set to 0 for each received CRC error. CRC errors requires CRC to be enabled.
MFAS - (MFAS Distant) controls the TS16 frame 0 "Y" bit. The MFAS SEC result increments when TS16 multiframing is ON and the "Y" bit = 1. When the "Y" bit is set to 0, MFAS is off.
T16AIS - (Timeslot 16 AIS) when T16AIS is ON, the TS16 AIS alarm is transmitted.

3.4.7 FRWORD

FRWORD - displays the modify frame words menu and allows modification of the bits in the NFAS and MFAS words. The modify frame word menu choices are: NFAS and MFAS. Pressing the softkey below the corresponding menu item displays the corresponding menu.

1. **NFAS WORD** - The NFAS word is displayed on the top line and the HELP menu item is displayed on the bottom line. Pressing the softkey below the HELP menu item displays the message: **Edit binary digits with the keypad**. Pressing the 0 or 1 key on the keypad sets the binary status at the cursor position to the corresponding value and moves the cursor to the next bit position to the right. Only the 5 least significant bits (national bits) can be changed from this menu if CRC is enabled. If CRC4 is set OFF, the Si bit can be set to 1 or 0. The left-arrow key and right-arrow key can be used to change the cursor position. After changing the status of any bit, press the ENTER switch to save the new NFAS word byte value. NOTE: If the ENTER switch is not pressed after changing the byte value, after exiting this menu, the NFAS word binary value is returned to the last saved value. Bit 3 (the "A" bit) is controlled by the FAS DIS ALARM.

2. **MFAS WORD** - The MFAS word is displayed on the top line and the HELP menu item is displayed on the bottom line. Pressing the softkey below the HELP menu item displays the message: **Edit binary digits with the keypad**. Pressing the 0 or 1 key on the keypad sets the binary status at the cursor position to the corresponding value and moves the cursor to the next bit position to the right. Only the 3 "x" bits (spare bits) of this byte can be changed from this menu. The left-arrow key and right-arrow key can be used to change the cursor position. After changing the status of any bit, press the ENTER switch to save the new MFAS word byte value. NOTE: If the ENTER switch is not pressed after changing the byte value, after exiting this menu, the MFAS word binary value is returned to the last saved value. Bit 6 (the "Y" bit) is controlled by MFAS ALARM.

3.5 2.048M/NX64K INTERFACE MENU IN A FIREBERD 4000

The following paragraphs describe the 2.048M/Nx64K Interface menus and menu selections when operated in a FIREBERD 4000.

From the INTERFACE selection menu, pressing the softkey below the 2M/n64 menu item selects the 2.048M/Nx64K Interface as the active interface. With the 2.048M/Nx64K Data Interface selected, press the right arrow on the SETUP SELECT switch to view the first menu (the FRAMING menu). Repeatedly pressing the right arrow on the SETUP SELECT switch scrolls through each menu and cycles around to the beginning menu again. Pressing the left arrow on the SETUP SELECT switch scrolls backward through the menus. This allows the operator to quickly return to a previous menu without having to scroll through all the other menus.

The 2.048M/Nx64K Data Interface menu for the FIREBERD 4000 is illustrated in Figure 3-4 and explained in the following paragraphs. It is important to understand that the menu choices determine what menus are displayed and also what menu choices (configurations) are allowed. An example of this is the relationship between the FRAMING menu selection and the OPERATION MODE menu selection. Unframed is only allowed with the TLB and FULL2M operating mode choices. Refer to the following paragraphs for examples of the configuration interrelationships.

The first 2M/n64 menu is the FRAMING menu and the currently selected framing mode on the top line of the display. The two framing menu choices (UNFRAM and FRAMED) are visible on the bottom line of the display. As mentioned earlier, the

FRAMING menu choice is interrelated with the operating mode menu choice. Selecting UNFRAM when the operating mode is set to: Nx64k, N64INS, VOICE, or BRDCST causes the message **Current mode requires framing** to be flashed in the results display.

With the FRAMING menu set to UNFRAM, pressing the right arrow on the SETUP SELECT switch displays the INPUT menu. The CRC4/TS16 menu is not displayed because these choices are not available for unframed operation.

3.5.1 FRAMING

The FRAMING menu shows the currently selected 2M framing format on the top line and the choices (FRAMED or UNFRAM) on the bottom line. As mentioned previously, the OPERATION MODE menu selection and the FRAMING menu selection are interrelated. The framing selection also determines the next menu displayed when the right arrow is pressed on the SETUP SELECT switch.

With the FRAMING menu displayed, pressing the softkey below the desired menu item (FRAMED or UNFRAM) selects that function as the current framing format.

FRAMED - selects the framed format for use with all operating modes.

UNFRAM - selects the unframed format for use with FULL2M and TLB operating modes.

If this menu selection is set to UNFRAM and the selected mode requires framing, the message **Current mode requires framing** is flashed in the results display accompanied by an audible beep. To correct this condition, the FRAMING menu can be set to FRAMED, or the OPERATION MODE can be set to FULL2M or TLB.

3.5.2 CRC4/TS16

This menu is only displayed if the FRAMING menu is set to FRAMED. This menu is used to select the 2 Mbps multiframing formats. The CRC4/TS16 menu displays the corresponding menu item condition on the top line and the menu items on the bottom line. Pressing the softkey below the CRC4 or TS16 menu item toggles corresponding function between ON and OFF. The CRC4 menu item selection determines the number of menu items displayed in the TX ALARM menu.

CRC4 - selects use of the timeslot 0 Si bits for CRC multiframing. When CRC4 is enabled, the Si bits are used for CRC4 information. When set OFF, the Si bit is selectable from the NFAS WORD menu.

TS16 - selects the use of timeslot 16 for TS-16 multiframing. When TS16 is enabled, timeslot 16 is reserved for use of the ABCD signalling bits. If timeslot 16 has already been configured for use (e.g., configured as TX/RX in the Nx64 mode or as the RX timeslot in BRDCST mode), the previous configuration is overridden and accompanied by the message **Timeslot 16 was in use** is displayed in the results window accompanied by an audible beep. When TS16 is set OFF, normal data can be inserted in timeslot 16.

3.5.3 INPUT

The INPUT menu displays the current interface input impedance characteristics. Input choices are: TERM, BRDG, or MON.

TERM - connects the 75Ω or 120Ω termination resistor for the interface cable connection. This selection allows the interface to properly terminate an unterminated circuit.

BRDG - provides >1KΩ input termination for the interface cable connection. This allows the interface to be connected to a properly terminated circuit without disrupting traffic by loading the line.

MON - connects the 75Ω or 120Ω termination resistor and adds up to 30 dB of gain to compensate for the resistive loss encountered at resistively isolated 2Mbps monitor access points. This allows the interface to be connected to a properly terminated circuit at the resistively isolated 2Mbps monitor access point.

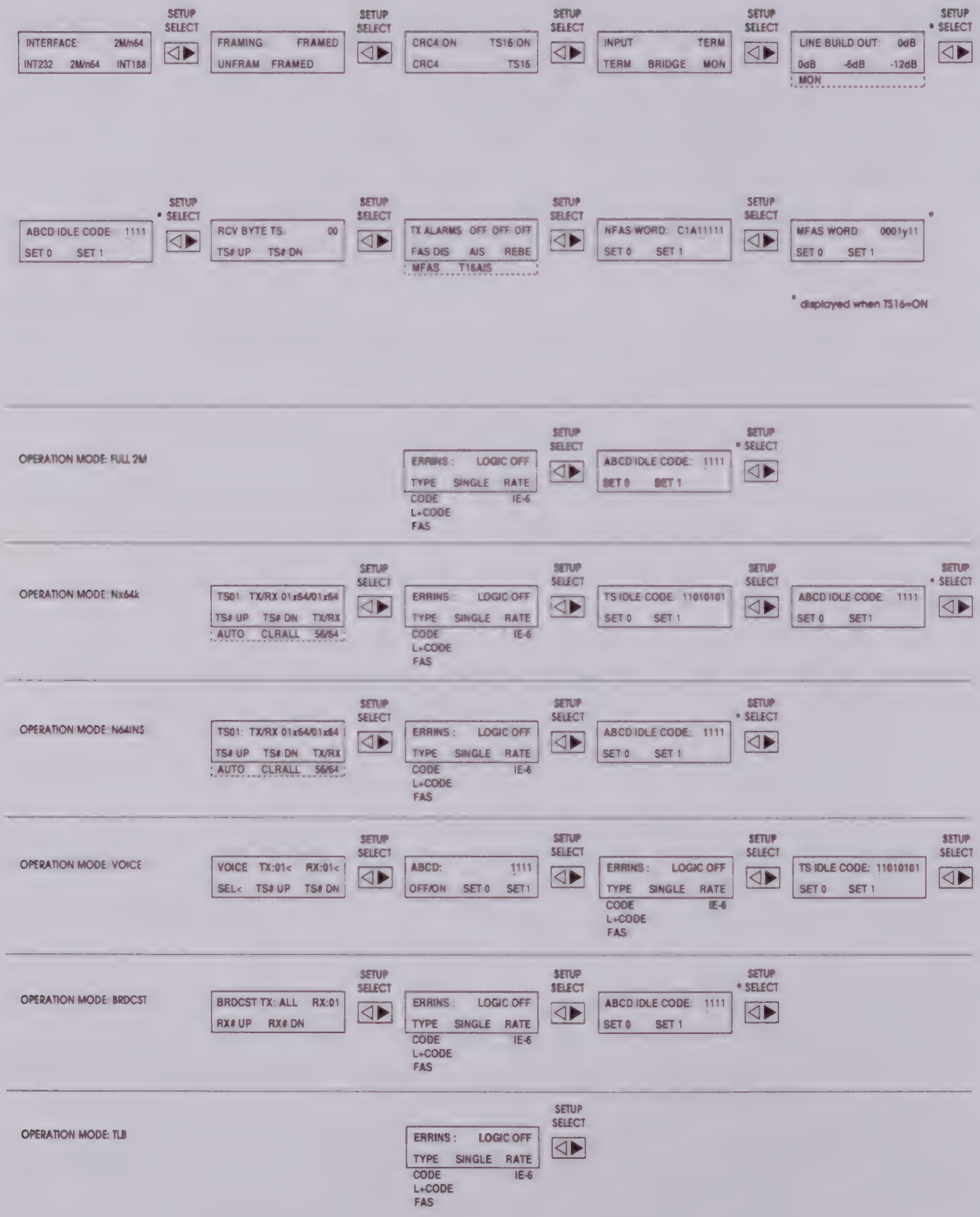

Figure 3-4
2.048M/NX64K Interface Menu for the FIREBERD 4000

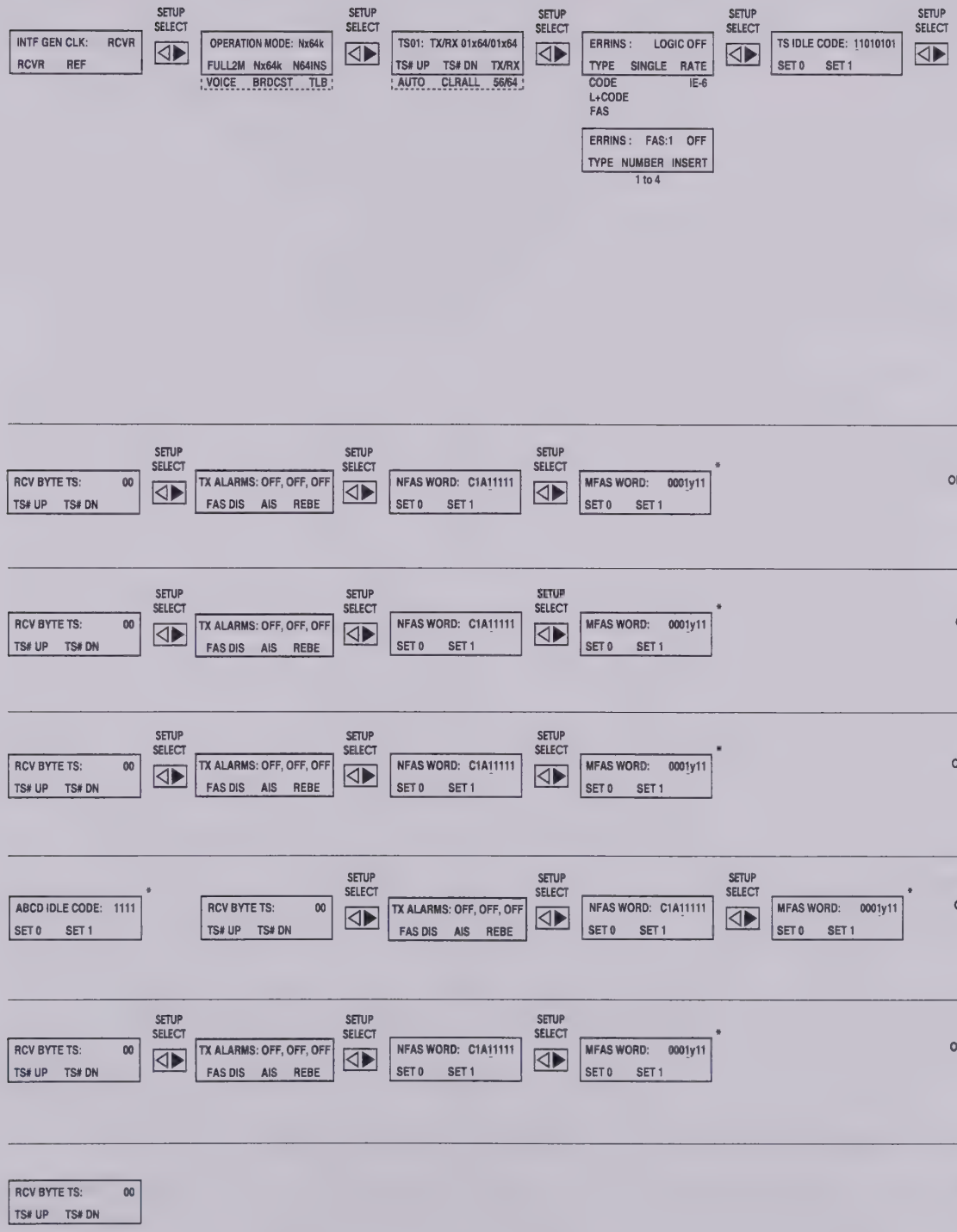

Figure 3-4
2.048M/NX64K Interface Menu for the FIREBERD 4000 (Continued)

3.5.4 LINE BUILD OUT

The LINE BUILD OUT menu controls the interface line build-out characteristics. Line build-out choices are: 0dB, -6dB, -12dB, or MON.

0dB - simulates 0 dB of cable loss.

-6dB - simulates passing the signal through enough cable to produce 6 dB of cable loss.

-12dB - simulates passing the signal through enough cable to produce 12 dB of cable loss.

MON - Simulates passing the signal through 30 dB of pure resistive attenuation, which would be found at a resistively isolated 2 Mbps monitor point.

3.5.5 INTF GEN CLK

The (INTF GEN CLK) interface generator clock menu controls the interface generator clock transmit timing source. This selection only affects the transmit clock when GENERATOR CLOCK is set to INTF (on the FIREBERD 4000 front panel). Interface clock choices are: RCVR or REF.

RCVR - selects the transmit timing clock source recovered from the received data.

REF - selects the signal at the interface BNC connector labeled 2.048M REF IN as the reference for the transmit timing source. Note that with REF selected, some residual jitter (up to 0.17UI) may be added to the transmitted signal.

3.5.6 OPERATION MODE

The OPERATION MODE menu determines the interface mode of operation. OPERATION MODE menu choices are: FULL2M, Nx64K, N64INS, VOICE, BRDCST, or TLB. Only the first three menu items are visible when this menu is first selected. Pressing the illuminated MORE switch displays the last three menu items.

1. **FULL2M** - selects the full 2.048 Mbps operating mode. This mode is selected to analyze the full 2.048M bandwidth.

   In FULL2M mode, the 2.048M/Nx64K Data Interface provides access to the entire 2048 kbps signal (2048 kbps for unframed operation, 1984 kbps for framed operation, or 1920 kbps for framed with TS16 set to ON), allowing the FIREBERD to analyze the signal. This mode allows the entire 2M bandwidth to be tested.

2. **Nx64k** - selects the Nx64k or Nx56k bit error analysis operating mode and displays its corresponding menu. Nx64k operation allows the user to perform bit error analysis on any combination of selected timeslots and select the desired timeslot(s) for testing. The top line of this menu displays the timeslot number (01 to 31), the timeslot status (TX/RX), and an indication of the total number of timeslots enabled for bit error analysis (in 64k or 56k increments). The softkeys below the first three menu items (TS# UP, TS# DN, and TX/RX) are used to scroll through the timeslots and to select the displayed timeslot status (TX/RX, TX/- -, - -/RX, or - -/- -). Pressing the MORE softkey displays the next three menu items (AUTO, CLRALL, and 56/64). Pressing the MORE softkey again displays the first three Nx64k menu items.

   In Nx64k mode, any number of transmit or receive timeslots can be selected. This allows individual timeslots or groups of timeslots to be tested.

   TS# UP - pressing the softkey below this menu item scrolls up through the available timeslots. Each time the TS# UP softkey is pressed, the TX/RX selection is blanked (set to - -/- -). When scrolling up, if TS16 (from the CONFIG menu) is enabled, the displayed timeslots increment from 15 to 17. Timeslot 16 is not displayed.

   TS# DN - pressing the softkey below this menu item scrolls down through the available timeslots. Each time the TS# UP softkey is pressed, the TX/RX selection is blanked (set to - -/- -). When scrolling down, if TS16 (from the CONFIG menu) is enabled, the displayed timeslots decrements from 17 to 15. Timeslot 16 is not displayed.

TX/RX - selects displayed the timeslot transmit and receive status. Repeatedly pressing the softkey below this menu item scrolls through the timeslot transmit/receive selections for the displayed timeslot. The TX/RX menu item choices are: TX/RX, TX/- -, - -/RX, or - -/- -.

TX/RX transmits and receives on the displayed timeslot.
TX/- - only transmits on the displayed timeslot.
- -/RX only receives on the displayed timeslot.
- -/- - sets the displayed timeslot to idle.

Inactive timeslots are filled with the 8-bit timeslot idle code (selectable from the IDLE menu).

AUTO - initiates a scan of the timeslots on the received signal. Each non-idle timeslot detected is set to TX/RX. This automatically configures the FIREBERD to the active timeslots on the Nx64 kbps signal. The message **Scanning...** is visible in the display while all timeslots are scanned to determine the active and idle timeslots. The message is not displayed when in self-loop mode.

CLRALL - resets all timeslots to - -/- -.

56/64 - selects the timeslot data rate for Nx64 kbps or Nx56 kbps analysis. Pressing the softkey below this menu item toggles the displayed data rate between 56 kbps and 64 kbps. When 64 kbps is selected, Nx64k analysis is performed. When 56 kbps is selected, Nx56k analysis is performed. The segment 2 setting of the DIP switch determines the position of the unused bit of each 56 kbps timeslot. Setting this segment to OPEN selects the MSB (1+7) as the unused bit and when set to CLOSED, the LSB (7+1) is selected as the unused bit.

3. **N64INS** - selects the Nx64 kbps insert operating mode, which allows the user to insert a BERT pattern on any combination of selected Nx64 kbps timeslots without disrupting traffic on the remaining timeslots. N64INS operation allows the user to select the desired timeslot(s) for testing. The key difference from Nx64k operation is that in N64INS operation, the unused timeslots at the output of the FIREBERD are filled with data received in that timeslot. Refer to the preceding Nx64k menu item descriptions for an explanation of the N64INS menu items.

   In Nx64k insert mode, the setup is identical to the Nx64k mode, except the unused timeslots are filled with received data in the same timeslots (instead of the 8-bit idle code). When the TS16 menu item is enabled, timeslot 16 is considered unused. Thus the output of this timeslot is filled with received data. This mode is not valid with SELF LOOP on.

4. **VOICE** - selects the voice operating mode and displays its corresponding menu. The type of voice encoding (A-Law or μ-Law) is determined by the segment 3 setting of the DIP switch. The OPEN posiiton selects μ-Law encoding and the CLOSED position selects A-Law encoding. Voice operation allows the user to select the μ-Law or A-Law encoded transmit and receive timeslot(s), and to set the ABCD signalling bits for the selected transmit timeslot. In the voice mode, one timeslot is selected for monitoring, or separate timeslots selected for talk and listen. The selected transmit timeslot contains the PCM μ-Law or A-Law encoded information from the handset. The received signalling bits can be monitored via the ANALYSIS RESULTS section on the FIREBERD front panel. If the selected timeslot transmission is enabled, the ABCD signalling bits can be changed if set to ON. To enable ABCD signalling, TS16 must not be set OFF.

   The three menu items (SEL<, TS# UP, and TS# DN) are visible on the bottom line. These menu items are described in the following paragraphs.

   SEL< - selects the whether the TX and/or RX timeslot is selected for modification with the TS# UP and TS# DN softkeys. Pressing the softkey below this menu item toggles the TX or RX menu item selection as follows:

   TX:01< RX:01< - the TX and RX timeslots are changed by the TS# UP or TS# DN key
   TX:01 RX:01< - only the RX timeslot is affected by the TS# UP or TS# DN key
   TX:01< RX:01 - only the TX timeslot is affected by the TS# UP or TS# DN key

   The < indicates that the associated timeslot (TX or RX) is selected.

   TS# UP - pressing the softkey below this menu item scrolls up through the available timeslots. When scrolling up, if TS16 (from the CONFIG menu) is enabled, the displayed timeslots increments from 15 to 17 and skips 16.

TS# DN - pressing the softkey below this menu item scrolls down through the available timeslots. When scrolling down, if TS16 (from the CONFIG menu) is enabled, the displayed timeslots decrements from 17 to 15 and skips 16.

5. **BRDCST** - selects the broadcast operating mode. Pressing the softkey below the BRDCST menu item displays the broadcast menu. The top line displays the selected receive timeslot. The softkeys below the RX#UP and RX#DN menu items, on the bottom line, are used to select the desired receive timeslot (01 to 31) on which to perform BER testing. When scrolling up or down, if TS16 (from the CONFIG menu) is enabled, the displayed timeslots skips timeslot 16. Note that the keypad keys can also be used to select the desired timeslot. However, if the keypad keys are used to enter timeslot 16 and TS16 is set On, the message **Timeslot 16 is set for ABCD signalling** is flashed in the results window and an audible tone is generated and the timeslot selection defaults to 15.

   In broadcast mode, the entire pattern is inserted into each timeslot and repeated either 30 times (if TS16 is On) or 31 times (if TS16 is Off) for Nx64K mode only. The first 8 bits are inserted in timeslot 1, the first 8 bits into timeslot 2, etc. until the entire pattern is transmitted. One timeslot must be specified to receive the transmitted pattern.

6. **TLB** - selects the test loopback mode of operation. The TLB operating mode loops back the entire 2048 kbps data stream from the input to the output of the FIREBIRD. Logic error, code error, and jitter injection are possible, however, FAS error insertion is not supported in TLB mode.

   In the TLB mode, the full received 2048 kbps is looped back to the transmit output. At the receive input, analysis is performed on all the timeslots (similar to FULL2M). The data is re-clocked and code errors are corrected before retransmission. TLB mode is not available when SELF LOOP is on.

3.5.7 ABCD

The ABCD menu is displayed after the OPERATION MODE menu when VOICE is selected and the TS16 menu item is enabled. If the TS16 menu item is set OFF, the ERRINS menu is displayed. The three menu items are displayed on the bottom line. The three menu items are: OFF/ON, SET0, and SET1.

The TS16 menu item must be enabled and the VOICE operating mode selected to use the ABCD signalling bits. Pressing the softkey below the ON/OFF menu item selects either the idle code or a user-programmable ABCD code to be transmitted in the selected timeslot. The left-arrow key and right-arrow key can be used to change the cursor position. After changing the status of any signalling bit, press the ENTER switch to save the new signalling bit value. Note that if the ENTER key is not pressed after changing the signalling bit value, after exiting this menu, the signalling bit value is returned to the last saved value.

OFF/ON - selects the user-programmable signalling bits (ON) or displays IDLE (OFF).

SET0 - sets the bit value at the cursor position to 0.

SET1 - sets the bit value at the cursor position to 1.

3.5.8 ERRINS

ERRINS - selects the error insertion type and number. Pressing the softkey below the ERRINS menu item displays the error insertion menu. The top line indicates the type of error (LOGIC, CODE, L+CODE, or FAS) selected and its current status. The following paragraphs describe the menu choices available for the error insertion menu.

NOTE: When inserting logic errors from the 2M/n64 menu, it is important to understand that not every time the softkey below the SINGLE softkey is pressed that the number of bit errors increases by 1. A logic error may not be detected if the bit error occurs in an idle timeslot, timeslot 16 if TS16 multiframing is on, in the international bit or national bits, or occurs in the FAS word. Using the front panel ERROR INSERT switch always inserts a detected bit error.

1. **TYPE** - pressing the softkey below this menu item scrolls through the error insertion types. Error insertion selections are: LOGIC (bit error), CODE, L+CODE, or FAS (TS0 error). Selecting FAS word error insertion changes the error insertion menu visible in the display window.

2. **FAS** - with FAS error insertion selected, pressing the softkey below the NUMBER menu increments the number of FAS errors from 1 to 4. Pressing the softkey below the INSERT menu item inserts the selected number (1 to 4) on 1 to 4 consecutive FAS words and momentarily flashes that number on the top line of the display. FAS error insertion does not operate in TLB mode, but does operate in all other modes.

3. **SINGLE** - pressing the softkey below this menu item causes a single error of the selected type (LOGIC, CODE, or L+CODE) to be inserted in the transmit data stream and 1 to be flashed in place of OFF on the top line of the display.

4. **RATE** - pressing the softkey below this menu item displays the 1E-6 error insertion rate. Rate is not available for FAS error insertion.

Depending on the interface configuration, one of three menus can be displayed when the right arrow on the SETUP SELECT switch is pressed. These menus are: RCV BYTE, ABCD IDLE CODE, or TS IDLE CODE. The menu displayed is determined by the CRC4/TS16 and OPERATION MODE menu selections.

3.5.9 RCV BYTE TS

RCVBYT - selects the timeslot (00 to 31) to be displayed in the RX BYTE result. Pressing the softkey below the TS# UP or TS# DN menu item increments or decrements the displayed timeslot respectively.

3.5.10 ABCD IDLE CODE

ABCD IDLE CODE - this menu displays the common channel idle code that is transmitted in timeslot 16, only if the TS16 menu item is enabled. The cursor position indicates the bit that is to be modified. Pressing the 0 or 1 key on the keypad sets the binary status at the cursor position to the corresponding value and moves the cursor to the next bit position to the right. The left-arrow key and right-arrow key can be used to change the cursor position. After changing the status of any ABCD idle code bit, press the ENTER switch to save the new idle code bit value.

NOTE: If the ENTER key is not pressed after changing the bit value, after exiting this menu, the idle code binary value is returned to the last saved value.

NOTE: An idle code of all 0s is not recommended, since all zeros emulates the TS16 multiframe alignment signal.

3.5.11 TS IDLE CODE

TS IDLE CODE - this menu displays the timeslot idle code that is transmitted in idle timeslots. The cursor position indicates the bit that is to be modified. Pressing the 0 or 1 key on the keypad sets the binary status at the cursor position to the corresponding value and moves the cursor to the next bit position to the right. The left-arrow key and right-arrow key can be used to change the cursor position. After changing the status of any timeslot idle code bit, press the ENTER switch to save the new idle code bit value. Note that if the ENTER switch is not pressed after changing the bit value, after exiting this menu, the idle code binary value is returned to the last saved value.

3.5.12 TX ALARMS

ALARMS - displays the transmit alarm menu. This menu is used to transmit 2.048M alarms to test 2.048M transmission equipment. The transmit alarm menu displays the status of the transmit alarms on the top line and the corresponding alarm on the bottom line. When the 2.048M/NX64K Interface is first selected, all the transmission alarms default to OFF. Transmission alarm choices are: FASDIS, AIS, REBE, MFAS, and T16AIS. The alarms displayed is determined by the CRC4/TS16 menu selection. Pressing the softkey below the menu item on the bottom line toggles the alarm condition on the top line. For example, if the top line displays OFF for AIS, pressing the softkey below the AIS menu item toggles the alarm status on the top line from OFF to AIS. All the other transmission alarms function in the same way, except REBE. When CRC4 is enabled, REBE is available as a TS ALARM menu item. Pressing the softkey below the REBE menu item displays the following choices: REBE, AUTO, or OFF.

Transmitting the various alarms cause the following conditions to occur.

FAS DIS -	(FAS Distant) controls the NFAS "A" bit. When OFF, A = 0 and when ON, A = 1.
AIS -	(Alarm Indication Signal) sends an unframed "all ones" signal.
REBE -	(Remote End Block Error) controls the NFAS "E" bits (Si bits) in frames 13 and 15. When OFF, E = 1 and when ON (REBE), E = 0. When AUTO is selected, "E" normally is set to 1 with a single E bit set to 0 for each received CRC error. CRC errors requires CRC to be enabled.
MFAS -	(MFAS Distant) controls the TS16 frame 0 "Y" bit. The MFAS SEC result increments when TS16 multiframing is ON and the "Y" bit = 1. When the "Y" bit is set to 0, MFAS is off.
T16AIS -	(Timeslot 16 AIS) when T16AIS is ON, the TS16 AIS alarm is transmitted.

3.5.13 NFAS WORD

NFAS WORD - The NFAS word (C1A11111) is displayed on the top line and the SET0 and SET1 menu items are displayed on the bottom line. Pressing the SET 0 or SET 1 softkey sets the binary status at the cursor position to the corresponding value and moves the cursor to the next bit position to the right. Only the 5 least significant bits (national bits) can be changed from this menu if CRC is enabled. If CRC4 is set OFF, the Si bit can be set to 1 or 0. The left-arrow key and right-arrow key can be used to change the cursor position. After changing the status of any bit, press the ENTER switch to save the new NFAS word byte value. Note that if the ENTER switch is not pressed after changing the byte value, after exiting this menu, the NFAS word binary value is returned to the last saved value. Bit 3 (the "A" bit) is controlled by the FAS DIS ALARM. Bit 1 (the "C" bit is controlled by the CRC4 menu selection) is set to 1 when CRC4 is Off.

3.5.14 MFAS WORD

MFAS WORD - The MFAS word (0001y111) is displayed on the top line and the SET0 and SET1 menu items are displayed on the bottom line. Pressing the SET 0 or SET 1 softkey sets the binary status at the cursor position to the corresponding value and moves the cursor to the next bit position to the right. Only the 3 "x" bits (spare bits) of this byte can be changed from this menu. The left-arrow key and right-arrow key can be used to change the cursor position. After changing the status of any bit, press the ENTER switch to save the new MFAS word byte value. Note that if the ENTER switch is not pressed after changing the byte value, after exiting this menu, the MFAS word binary value is returned to the last saved value. Bit 6 (the "Y" bit) is controlled by MFAS ALARM (as viewed in the RCV MFAS analysis result).

3.6 INTERFACE PATTERN SELECTION

In addition to the patterns described in the FIREBERD Reference Manual, a new pattern (1020Hz) has been added. The 1020Hz pattern has been added to the USER PATTERN (AUX 41) in the FIREBERD 6000 and to the PATTERN category in the FIREBERD 4000.

In the FIREBERD 6000, set the DATA pattern to USER, then select the AUXILIARY menu item, and then select Auxiliary Function 41 to access the 1020Hz pattern. Press the MORE switch until the 1020Hz menu item is visible in the display. Pressing the softkey below this menu item selects the 1020Hz pattern for insertion into the transmission data stream. This pattern is the standard tone used in CCITT voice frequency (VF) testing.

1020Hz - this pattern is available under the USER pattern category in the FIREBERD 6000 and under the PATTERN category in the FIREBERD 4000. This pattern is the digital A-Law encoded 1020 Hz tone with a 0 dBm0 level. The 1020 Hz digitized tone is inserted in the selected transmit timeslot(s).

3.7 INTERFACE ERROR MESSAGES

During operation of the 2.048M/Nx64 Interface, messages may be visible in the display window. Table 3-3 lists the message displayed and the cause for the displayed message.

Table 3-3
Interface Error Messages

Error Message	Caused By	Result
This selection requires framing	Pressing the softkey below the INSERT menu item to insert FAS errors, from the ERRINS menu, while Unfram was selected.	No affect.
Current mode requires framing	The Unfram was selected, from the CONFIG (CRC4/TS16) menu, and the mode was set to Nx64k, N64INS, BRDCST, or VOICE.	Improper operation until properly configured.
Timeslot 16 was in use	Enabling TS16, from the CONFIG (CRC4/TS16) menu, while Nx64k, N64INS, BRDCST, or VOICE modes are configured to use timeslot 16 for data or voice.	TS16 is enabled and the other uses of TS16 are either removed (Nx64k or N64INS) or changed to use timeslot 15 (BRDCST or VOICE).
No FAS error ins in TLB mode	Pressing the softkey below the INSERT menu item to insert FAS errors, from the ERRINS menu, while in TLB operating mode.	No affect.
TS16 is set for ABCD signalling	16 was entered using the keypad keys to select TS16 for data or voice, from in the MODE menu, while TS16 was enabled.	Timeslot 15 is selected instead.
This selection requires TS16 sig	Pressing the softkey below the ABCD menu item, from the ERRINS menu, while TS16 was disabled.	No affect.

3.8 INTERFACE INDICATORS

With the 2.048M/Nx64 Interface installed, FIREBERD front panel indicators are used to indicate interface-specific conditions. Only those indicators unique to this interface are described in the following paragraphs.

FRAME SYNC - this LED illuminates when configuration is set to FRAMED and frame synchronization has been achieved. If CRC4 is enabled, frame synchronization is not declared until CRC4 multiframe sync is obtained. If TS16 is enabled, frame synchronization is not declared until TS16 multiframe sync is obtained. If both CRC4 and TS16 are enabled, frame sync is not declared until both CRC4 and TS16 multiframe sync are obtained.

ALM 1 - this LED illuminates when FAS Distant alarm is being received (the A-bit is set to 1)

ALM 2 - this LED illuminates when AIS is being received.

ALM 3 - this LED illuminates when MFAS Distant alarm is being received*.

NOTE: The CODE LED is not used when the 2.048M/Nx64 Interface is selected.
* Only available for the FIREBERD 4000.

3.9 INTERFACE ANALYSIS RESULTS

With the 2.048M/Nx64 Data Interface installed in a FIREBERD 6000, the analysis results listed in Table 3-4 are available. Similarly, with the 2.048M/Nx64 Data Interface installed in a FIREBERD 4000, the analysis results listed in Table 3-5 are available.

Table 3-4
FIREBERD 6000 2.048M/Nx64 Interface-Specific Analysis Results

Category	Displayed Result	Description
ERROR	BIT ERRS	Bit errors
	AVG BER	Average bit errors
	BER	Bit error rate
	PAT SLIP	Pattern slips
PERFORMANCE	DEG MIN	Degraded minutes
	% DEG MIN	Percent degraded minutes
	SES	Severely errored seconds
	%SES	Percent severely errored seconds
	UNA SEC	Unavailable seconds
	AVL SEC	Available seconds
	% AVL SEC	Percent available seconds
	ERR-SES	Bit errors over non-severely errored seconds
	BER-SES	Bit error rate over non-severely errored seconds
	GERR SEC	G.821 errored seconds
	G EFS	G.821 error free seconds
	G %EFS	G.821 percent error free seconds
	%SVS	Percent severely violated seconds
	G %VFS	G.821 percent violation free seconds
TIME	ELAP SEC	Elapsed seconds
	TIME	Time
	DATE	Date
	ERR EAS	Errored error analysis seconds
	EA SEC	Error analysis seconds
	EF EAS	Error free error analysis seconds
	PATL SEC	Pattern sync loss seconds
	% PAT SEC	Percent synchronized seconds
SIGNAL	GEN FREQ	Generator clock frequency
	RCV BYTE	Receive timeslot byte
	+LVL dB	Positive level in decibels
	-LVL dB	Negative level in decibels
	+WNDR	Positive wander peak (UI)
	-WNDR	Negative wander peak (UI)
	PP WNDR	Peak-to-peak wander (UI)
	15m WNDR	Maximum peak-to-peak wander in last 15 minutes
	24h WNDR	Maximum peak-to-peak wander in last 24 hours
	RCV FREQ	Receiver clock frequency
T-CARRIER	CODE ERR	Code errors (per CCITT O.161)
	AVG CER	Average code error rate
	CER	Test interval* code error rate
	FRA LOSS[4]	Frame sync loss
	BIT SLIP	Bit slips (UI)
	FAS ERR[4]	FAS word errors

Table 3-4
FIREBERD 6000 2.048M/Nx64 Interface-Specific Analysis Results (Continued)

Category	Displayed Result	Description
T-CARRIER (Continued)	AVG FAS[4]	Average FAS word error rate
	FAS E Rt[4]	Test interval* FAS word error rate
	RCV NFAS[4]	Received NFAS word
	MFAS ERR[2]	MFAS word errors
	MFS E Rt[2]	Test interval* MFAS error rate
	AVG MFAS[2]	Average MFAS error rate
	VF EAS	Violation free error analysis seconds
	%VF EAS	Percent violation free error analysis seconds
	CRC ERR[1]	CRC errors
	CRC E Rt[1]	Test interval* CRC error rate
	AVG CRC[1]	Average CRC error rate
	1 SEC CRC	1 second CRC count
	REBE[1]	Remote end block errors
	REBE Rt[1]	Test interval* REBE rate
	AVG REBE[1]	Average remote end block error
	RCV FAS[4]	Received FAS word
	RCV MFAS[2]	Received MFAS word
	RX ABCD[2,3]	Received ABCD
ALARM	AIS SEC	AIS seconds
	T16AIS S[2]	Timeslot 16 AIS seconds
	FADIS S[4]	FAS distant alarm seconds
	MF DIS S[2]	MFAS distant alarm seconds

NOTE: *Test interval is the number of bits or time over which the error rate is measured.
[1]Only with CRC4 framing.
[2]Only with TS16 framing.
[3]Only in voice mode.
[4]Only with framed data.

Table 3-5
FIREBERD 4000 2.048M/Nx64 Interface-Specific Analysis Results

Category	Displayed Result	Description
ERROR	BIT ERRS	Bit errors
	AVG BER	Average bit errors
	BER	Bit error rate
	PAT SLIP	Pattern slips
PERFORMANCE	DEG MIN	Degraded minutes
	% DEG MIN	Percent degraded minutes
	SES	Severely errored seconds
	%SES	Percent severely errored seconds
	UNA SEC	Unavailable seconds
	AVL SEC	Available seconds
	% AVL SEC	Percent available seconds
	ERR-SES	Bit errors over non-severely errored seconds

Table 3-5
FIREBERD 4000 2.048M/Nx64 Interface-Specific Analysis Results (Continued)

Category	Displayed Result	Description
PERFORMANCE (Continued)	BER-SES	Bit error rate over non-severely errored seconds
	GERR SEC	G.821 errored seconds
	G EFS	G.821 error free seconds
	G %EFS	G.821 percent error free seconds
	%SVS	Percent severely violated seconds
	G %VFS	G.821 percent violation free seconds
TIME & SIGNAL	ELAP SEC	Elapsed seconds
	TIME	Time
	DATE	Date
	ERR EAS	Errored error analysis seconds
	EA SEC	Error analysis seconds
	EF EAS	Error free error analysis seconds
	PATL SEC	Pattern sync loss seconds
	% PAT SEC	Percent synchronized seconds
	GEN FREQ	Generator clock frequency
	+LVL dB	Positive level in decibels
	-LVL dB	Negative level in decibels
	+WNDR	Positive wander peak (UI)
	-WNDR	Negative wander peak (UI)
	PP WNDR	Peak-to-peak wander (UI)
	15m WNDR	Maximum peak-to-peak wander in last 15 minutes
	24h WNDR	Maximum peak-to-peak wander in last 24 hours
	RCV FREQ	Receiver clock frequency
INTERFACE	CODE ERR	Code errors (per CCITT O.161)
	AVG CER	Average code error rate
	CER	Test interval* code error rate
	FRA LOSS[4]	Frame sync loss
	BIT SLIP	Bit slips (UI)
	FAS ERR[4]	FAS word errors
	AVG FAS[4]	Average FAS word error rate
	FAS E Rt[4]	Test interval* FAS word error rate
	RCV FAS[4]	Received FAS word
	RCV NFAS[4]	Received NFAS word
	MFAS ERR[2]	MFAS word errors
	MFS E Rt[2]	Test interval* MFAS error rate
	AVG MFAS[2]	Average MFAS error rate
	CRC ERR[1]	CRC errors
	CRC E Rt[1]	Test interval* CRC error rate
	AVG CRC[1]	Average CRC error rate
	RCV BYTE	Receive timeslot byte
	REBE[1]	Remote end block errors
	REBE Rt[1]	Test interval* REBE rate
	AVG REBE[1]	Average remote end block error
	RCV MFAS[2]	Received MFAS word
	RCV ABCD[2,3]	Received ABCD
	T16AIS S[2]	Timeslot 16 AIS seconds

NOTE: *Test interval is the number of bits or time over which the error rate is measured.
[1]Only with CRC4 framing.
[2]Only with TS16 framing.
[3]Only in voice mode.
[4]Only with framed data.

3.10 ANALYSIS RESULTS DEFINITIONS

% Available Seconds (%AVL SEC) - The ratio of the number of available seconds to the number of test seconds since initial pattern synchronization, expressed as a percentage.

% Degraded Minutes (%DEG MIN) - The ratio of the number of degraded minutes to the number of minutes derived from available, non-severely errored seconds, expressed as a percentage.

% Pattern Sync Seconds (%PAT SEC) - The ratio of the number of seconds in which pattern synchronization was achieved with no synchronization losses to the total number of seconds since initial pattern synchronization, expressed as a percentage.

% Violation Free Error Analysis Seconds (%VF EAS) - The number of violation free error analysis seconds to the number of error analysis seconds since the beginning of the test.

% Severely Errored Seconds (%SES) - The ratio of the number of severely errored seconds to the number of available seconds, expressed as a percentage.

% Severely Violated Seconds (%SVS) - The ratio of the number of severely violated seconds to the number of available seconds, expressed as a percentage.

1 Second CRC (1SEC CRC) - The number of CRC errors counted in one second.

15-Minute Wander (15m WNDR) - The maximum peak-to-peak wander deviation over the last 15 minutes of the test. This result is unavailable during the first 15 minutes of the test and is updated once per minute thereafter.

24-Hour Wander (24h WNDR) - The maximum peak-to-peak wander deviation over the last 24 hours of the test. This result is unavailable during the first 24 hours of the test and is updated once per hour thereafter.

Alarm Indication Signal Seconds (AIS SEC) - The number of seconds since the beginning of the test in which the AIS alarm was active.

Available Seconds (AVL SEC) - The number of seconds judged available by CCITT criteria.

Average Bit Error Rate (AVG BER) - The ratio of the number of bit errors counted to the number of data bits examined since the beginning of the test.

Average Code Error Rate (AVG CER) - In 2048 kbps testing, the ratio of the number of code errors detected to the number of data bits examined since the beginning of the test.

Average CRC Errors (AVG CRC) - The ratio of the number of CRC errors detected to the number of CRCs examined since the beginning of the test.

Average FAS Error Rate (AVG FAS) - In 2048 kbps testing, the ratio of the number of FAS errors detected to the number of frame words examined since the beginning of the test.

Average Multiframe Alignment Signal Error (AVG MFAS) - The ratio of errored MFAS words to the total number of MFAS words detected.

Average Remote End Block Errors (AVG REBE) - The ratio of remote end block errors to the total number of blocks received.

Bit Error Rate (BER) - The ratio of the number of bit errors counted over the last test interval to the number of data bits examined in the last test interval.

Bit Errors (BIT ERRS) - The number of errored data bits counted since the beginning of the test.

Bit Errors Over Non-Severely Errored Seconds (BER-SES) - The bit error rate, excluding the errors that occurred during severely errored seconds.

Bit Errors Over Non-Severely Errored Seconds (ERR-SES) - The total number of bit errors, excluding the errors that occurred during severely errored seconds.

Bit Slips (BIT SLIP) - In E1 testing, the number of bit slips in a frame, ranging from -32767 to +32767.

Code Error Rate (CER) - In 2048 kbps testing, the ratio of the number of code errors detected over the last test interval to the number of data bits examined.

Code Errors (CODE ERR) - In 2048 kbps testing, the number of code errors detected in the received signal.

CRC Error Rate (CRC E Rt) - The ratio of the number of CRC errors detected over the last test interval to the number of CRCs examined.

CRC Errors (CRC ERR) - The number of CRC errors detected since the beginning of the test.

DATE - The calendar date in day, month, and year. The current date is set using auxiliary function 60.

Degraded Minutes (DEG MIN) - The number of blocks of 60 non-severely errored, available seconds in which the average BER was worse than 10^{-6}. Note that CCITT Recommendation G.821 eases this requirement at 64 kHz; when the average BER over 60 seconds is 64 kHz, and four bit errors are counted, the minute is not considered to be degraded.

Delay (DELAY) - The most recently measured time interval between the start and finish of specific events. The start and stop events are selected using Auxiliary Function 31.

Elapsed Seconds (ELAP SEC) - The number of seconds, based on the time-of-day clock, since the last major switch change or test restart.

Error Analysis Seconds (EA SEC) - The amount of time during which error analysis has been performed, expressed in seconds. The time that error analysis is performed depends on receiver pattern synchronization and the setting of Auxiliary Function 03 (Receiver Action Upon Sync Loss).

Error-Free Error Analysis Seconds (EF EAS) - The number of error analysis seconds during which no bit errors were detected.

Errored Error Analysis Seconds (ERR EAS) - The number of error analysis seconds during which one or more bit errors were detected. Errored error analysis seconds are asynchronous.

FAS Error Rate (FAS E Rate) - In 2048 kbps testing, the ratio of the number of FAS errors detected over the last test interval to the number of frame words examined in the last test interval.

Frame Alignment Signal Distant Alarm Seconds (FAS DIS S) - A count of the number of seconds in which the distant FAS is detected.

Frame Alignment Signal Errors (FAS ERR) - In 2048 kbps testing, the number of FAS errors detected since the beginning of the test.

G.821 % Error-Free Seconds (G %EFS) - The ratio of the number of available seconds in which no errors were detected to the total number of available seconds, expressed as a percentage.

G.821 %Violation-Free Seconds (G %VFS) - The ratio of the number of available seconds in which BPVs were not detected to the total number of available seconds, expressed as a percentage.

G.821 Error-Free Seconds (G EFS) - The number of available seconds in which no bit errors occurred.

G.821 Errored Seconds (GERR SEC) - The number of available seconds in which at least one bit error occurred.

G.821 Violation-Free Seconds (G VFS) - The number of available seconds in which BPVs were not detected.

Generator Frequency (GEN FREQ) - The current measurement of the generator clock frequency.

Multiframe Alignment Signal Distant Alarm Seconds (MF DIS S) - A count of the number of seconds in which the distant MFAS is detected.

Multiframe Alignment Signal Word Error (MFAS ERR) - The number of errored MFAS words detected in TS16.

Negative Receive Level in Decibels (-LVL dB) - The level of the received signal in dB, relative to the negative level measurement. The range and resolution of this measurement are interface-dependent.

Negative Wander (-WNDR) - The maximum negative peak wander deviation since the beginning of the test, expressed in UIs.

One-Second CRC Errors (1 SEC CRC) - The number of CRC errors counted in the last test second.

Pattern Slips (PAT SLIP) - The number of occurrences since the beginning of the test where data bits have been added to or deleted from the received pattern.

Pattern Sync Loss Seconds (PATL SEC) - The number of seconds during which the receiver was not in continuous pattern synchronization.

Pattern Synchronization Loss Count (PAT LOSS) - The number of times a pattern synchronization loss is detected.

Peak-To-Peak Wander (PP WNDR) - The total deviation of positive-to-negative peak wander since the beginning of the test, expressed in UIs.

Positive Receive Level in Decibels (+LVL dB) - The level of the received signal in decibels, relative to the positive level measurement. The range and resolution of this measurement are interface-dependent.

Positive Wander (+WNDR) - The maximum positive peak wander deviation since the beginning of the test, expressed in UIs.

Receive Byte (RCV BYTE) - The received data bytes displayed in binary form.

Received ABCD (RX ABCD) - In E1 testing, the ABCD signal of a DS0 channel selected via the interface set-up menu.

Received Frame Alignment Signal Word (RCV FAS) - The received FAS word.

Received Multiframe Alignment Signal Word (RCV MFAS) - The received MFAS word.

Received Not Frame Alignment Signal Word (RCV NFAS) - The received not FAS word.

Receiver Frequency (RCV FREQ) - The current measurement of the receiver clock frequency.

Remote End Block Error Rate (REBE Rt) - The rate at which remote end block errors are detected.

Remote End Block Errors (REBE) - The number of remote end block errors detected.

Severely Errored Seconds (SES) - The number of available seconds during which the BER is higher than 10^{-3}.

Severely Violated Seconds (SVS) - The number of available seconds during which the BPV rate was higher than 10^{-3}.

Signal Loss Seconds (SIGL SEC) - The number of seconds during which the signal was not present for any part of the second.

Time of Day (TIME) - The time of day in hours, minutes, and seconds. Hours are displayed in a 24-hour format. The current time is set using auxiliary function 60.

Timeslot 16 Alarm Indication Signal Seconds (T16AIS S) - A count of the number of seconds in which the AIS occurred in timeslot 16.

Unavailable Seconds (UNA SEC) - The number of seconds judged unavailable by CCITT criteria.

Violation Free Error Analysis Seconds (VF EAS) - The number of error analysis seconds during which no BPVs or code errors were detected.

3.11 FIREBERD PRINTER OPERATION

With the FIREBERD mainframe connected to a suitable serial printer, results and controls printouts can be generated. The items printed out and print format are determined by the printer used, the FIREBERD mainframe configuration, the 2.048M/NX64K Interface mode, and other interface parameters. Figure 3-5 illustrates a typical results print and Figure 3-6 illustrates a typical controls print.

MANUAL	PRINT		
21:04:46	18 JAN 93	BIT ERRS	1155
AVG BER	1.00E-03	BER	9.99E-04
PAT SLIP	0	PAT LOSS	0
PATL SEC	0	ERR SEC	18
G %EFS	0.00%	TEST SEC	18
CODE ERR	0	AVG CER	0. E-07
CER	0. E-07	FAS ERR	1
AVG FAS	1. E-05	MFAS ERR	0
AVG MFAS	0. E-03	CRC ERR	18
AVG CRC	1.0 E-03	1SEC CRC	0
REBE	0	AVG REBE	0. E-04
GEN FREQ	64000.0	RCV FREQ	64000.0
+LVL dB	0.0 dB	-LVL dB	0.0 dB
BIT SLIP	No Ref	+WNDR	No Ref
-WNDR	No Ref	PP WNDR	No Ref
15m WNDR	No Ref	24h WNDR	No Ref
RCV BYTE	11011111	RCV FAS	00011011
RCV NFAS	11011111	RCV MFAS	00001011
T16AIS S	0	ERR-SES	1086
BER SES	9.99E-04	GERR SEC	18
G EFS	0	%EFS	0.00%
UNA SEC	0	AVL SEC	18
%AVL SEC	100.00%	DEG MIN	0
%DEG MIN		SES	1
%SES	5.56%	ELAP SEC	18
FRAME SYNC PRESENT		FAS DIS ALM	NO
AIS	ABSENT	MFAS DIS ALM	NO
SELF LOOP	ON	IF	2.048M Nx64k

Figure 3-5
2.048M/NX64K Interface Long Results Print

CONTROLS	PRINT		
12:02:13	10 SEP 91	SITE:	Alpha
DATA:	2^15-1	ERROR INS:	OFF
SELF LOOP:	OFF	GEN CLOCK:	SYNTH
TIMING MODE:	N/A	SYN FREQ:	2048.0 kHz
INTERFACE:		2.048M Nx64k	
FRAME:	ON	CRC4:	OFF
TS16:	OFF	RESULTS MODE:	STD
INPUT:	TERM	LBO:	0dB
INTF GEN CLK:	REF	MODE:	NX64K
NX64K:	4x64/4x64	TxTS01-08:	11110000
TxTS09-16:	00000000	TxTS17-24:	00000000
TxTS25-31:	0000000	RxTS01-08:	11110000
RxTS09-16:	00000000	RxTS17-24	00000000
RxTS25-31:	0000000	ERR INS:	OFF
ERR TYPE:	LOGIC	NFAS WORD:	C1A11111
MFAS WORD:	00001Y11	IDLE TS:	11010101
IDLE ABCD:	1111	RCV BYTE TS:	3
TX FAS DIS:	OFF	TX AIS:	OFF
TX REBE:	OFF	TX MFAS DIS:	OFF
TX TS16 AIS:	OFF	TEST INT:	10^6
JITTER:	2M	RANGE:	BAND1
HIST:	6.0 UI	SPECTRUM ANALY:	
FREQ:	10 Hz	SWEEP:	OFF
GEN:		AMPL:	MASK
UI:	00.00	SWEEP:	ON
FREQ:	10 Hz	MOD:	OFF
MASK:	G.823	PRINT EVENT:	DELTA
TEST INT PRNT:	OFF	SYN LOSS PRNT:	OFF
ERROR PRNT:	OFF	TIME PRNT:	OFF
ANALY MODE:	CON	DISPLAY HOLD:	OFF
BLOCK LENGTH:			1000 BITS
DELAY:	DTR/DTR/	XON CHARACTER:	11
XOFF CHARACTER:	13	AUX FUNC IN USE:	
NONE		PRINT SPEED:	FAST
PRINT TERM:	CR LF	REMOTE:	NONE
PRINTER:	RS-232	RS-232:	
DATA BITS:	8	BAUD:	9600
PARITY:	NONE		

Figure 3-6
2.048M/NX64K Interface Controls Print

3.12 2.048M/NX64K INTERFACE REMOTE CONTROL COMMANDS

With the 2.048M/NX64K Interface installed in a FIREBERD mainframe, a suitable controller can remotely control the interface and the mainframe. Table 3-6 lists the remote control commands used to control the 2.048M/Nx64k Interface. The remote control syntax adheres to the IEEE-488.2 standard. For detailed instructions on remotely controlling the FIREBERD mainframe, refer to the *FIREBERD 6000 Reference Manual* or the *FIREBERD 4000 Reference Manual.*

Table 3-6
2.048 M/Nx64 Interface Module Remote Control Commands

Remote Command:	Activity:
INTF:N64_2M:CONFIG:FRAME?	:Request the current 2 Mb/s framing status (off or on)
INTF:N64_2M:CONFIG:FRAME [OFF|ON]	:Turns framing off or on
INTF:N64_2M:CONFIG:CRC4?	:Request the current status of CRC4 framing (off or on)
INTF:N64_2M:CONFIG:CRC4 [OFF|ON]	:Turn CRC4 framing off or on
INTF:N64_2M:CONFIG:TS16?	:Request the current status of TS-16 framing (off or on)
INTF:N64_2M:CONFIG:TS16 [OFF|ON]	:Turn TS-16 framing on or off
INTF:N64_2M:CONFIG:RESULT?	:Request the current result mode (standard or live)
INTF:N64_2M:CONFIG:RESULT [STD|LIVE]	:Select standard or live test result mode*
INTF:N64_2M:CONFIG:INPUT?	:Request the current input termination selection (term, bridge, or monitor)
INTF:N64_2M:CONFIG:INPUT [TERM|BRIDGE|MON]	:Select input termination
INTF:N64_2M:CONFIG:LBO?	:Request the current line buildout (0 dB, -6 dB, -12 dB, or MON)
INTF:N64_2M:CONFIG:LBO [0|-6|-12| MON]	:Select line buildout (MON=-30 dB pure resistive)
INTF:N64_2M:CONFIG:IF_CLK?	:Request the current interface clock source (receiver or reference)
INTF:N64_2M:CONFIG:IF_CLK [RCVR|REF]	:Select the interface generator clock source
INTF:N64_2M:MODE?	:Request the current interface operating mode (full 2 Mb/s, NX64 kbps transmit, NX64 kbps insert, broadcast, voice, or 2 Mb/s test loopback)
INTF:N64_2M:MODE [FULL2M|NX64K|N64INS|BRDCST|VOICE|TLB]	:Select the interface operating mode
INTF:N64_2M:NX64K?	:Request the number of active transmit and receive timeslots and the data rate in each (e.g., 5x64 kbps) in Nx64kbps *transmit* mode
INTF:N64_2M:NX64K [AUTO|CLEAR|56|64]	:Select timeslot configuration in Nx64 kbps transmit mode
INTF:N64_2M:NX64K:TXTS? (number)	:Request data transmit status of a specific timeslot (off or on) in Nx64 kbps transmit mode
INTF:N64_2M:NX64K:TXTS (number),[OFF|ON]	:Select a specific timeslot for, or remove a specific timeslot from, data transmit status in Nx64 kbps transmit mode

Table 3-6
2.048M/Nx64 Interface Module Remote Control Commands (Continued)

Remote Command:	Activity:
INTF:N64_2M:NX64K:TX_TIMESLOTS?	:Request the timeslots that are configured for data transmit in Nx64 kbps transmit mode
INTF:N64_2M:NX64K:RXTS? (number)	:Request data receive status of a specific timeslot (off or on) in Nx64 kbps transmit mode
INTF:N64_2M:NX64K:RXTS (number), [OFF|ON]	:Select a specific timeslot for, or remove a specific timeslot from, data receive status in Nx64 kbps transmit mode
INTF:N64_2M:NX64K:RX_TIMESLOTS?	:Request the timeslots that are configured for data receive in Nx64 kbps transmit mode
INTF:N64_2M:N64INS?	:Request the number of active transmit and receive timeslots and the data rate in each (e.g., 5x64 kbps) in Nx64 kbps insert mode
INTF:N64_2M:N64INS [CLEAR| 56|64]	:Select Nx64 kbps timeslot configuration in Nx64 kbps *insert* mode
INTF:N64_2M:N64INS:TXTS? (number)	:Request data transmit status of a specific timeslot (off or on) in Nx64 kbps insert mode
INTF:N64_2M:N64INS:TXTS (number),[OFF|ON]	:Select a specific timeslot for, or remove a specific timeslot from, data transmit status in Nx64 kbps insert mode
INTF:N64_2M:N64INS:TX_TIMESLOTS?	:Request the timeslots that are configured for data transmit in Nx64 kbps insert mode
INTF:N64_2M:N64INS:RXTS? (number)	:Request data receive status of a specific timeslot (off or on) in Nx64 kbps insert mode
INTF:N64_2M:N64INS:RXTS (number),[OFF|ON]	:Select a specific timeslot for, or remove a specific timeslot from, data receive status in Nx64 kbps insert mode
INTF:N64_2M:N64INS:RX_TIMESLOTS?	:Request the timeslots that are configured for data receive status in Nx64 kbps *insert* mode
INTF:N64_2M:BRDCST?	:Request the current timeslot in the received data stream that is selected for Bit Error Rate Testing (BERT)
INTF:N64_2M:BRDCST (number)	:Select a timeslot in the received data stream for BERT
INTF:N64_2M:VOICE?	:Request the current transmit and receive voice timeslots
INTF:N64_2M:VOICE (txts no.), (rxts no.)	:Select transmit and receive voice timeslots
INTF:N64_2M:VOICE:SIGNAL?	:Request the current status of voice signalling (off or on)
INTF:N64_2M:VOICE:SIGNAL [OFF|ON]	:Turn voice signalling off or on

Table 3-6
2.048M/Nx64 Interface Module Remote Control Commands (Continued)

Remote Command:	Activity:
INTF:N64_2M:VOICE:ABCD?	:Request the current ABCD signalling bits
INTF:N64_2M:VOICE:ABCD ("four-bit string")	:Select ABCD signalling bits
INTF:N64_2M:ERR_INSERT?	:Request the current error insertion selection (off, code, logic, logic plus code, single error insertion, or continuous error insertion at the specified rate)
INTF:N64_2M:ERR_INSERT [OFF|CODE|LOGIC|L+CODE|SINGLE|RATE]	:Select error insertion
INTF:N64_2M:ERR_INSERT:FAS (number)	:Select Frame Alignment Signal (FAS) error insertion and the number of consecutive FAS error to be inserted
INTF:N64_2M:ERR_RATE?	:Request the current error insertion rate
INTF:N64_2M:ERR_RATE (rate-string)	:Set the error insertion rate with range 1E-9 to 9E-3.*
INTF:N64_2M:IDLE:TS?	:Request the current timeslot idle code
INTF:N64_2M:IDLE:TS (binary number)	:Set the timeslot idle code (default: 11010101)
INTF:N64_2M:IDLE:ABCD?	:Request the current ABCD idle code (default: 1111)
INTF:N64_2M:IDLE:ABCD (four-bit string)	:Set the ABCD idle code
INTF:N64_2M:RCV_BYTE_TS?	:Request the current receive byte timeslot
INTF:N64_2M:RCV_BYTE_TS (number)	:Set the current receive byte timeslot
INTF:N64_2M:TXALARM:FASDIS?	:Request the current status of the FAS distant alarm (off or on)
INTF:N64_2M:TXALARM:FASDIS [OFF|ON]	:Enable (on) or disable (off) FAS distant alarm transmission
INTF:N64_2M:TXALARM:REBE?	:Request the current status of the Remote-End Bit Error (REBE) alarm (off or on)
INTF:N64_2M:TXALARM:REBE [OFF|ON|AUTO]	:Enable (on), disable (off), or set REBE alarm transmission to AUTO
INTF:N64_2M:TXALARM:AIS?	:Request the current status of the Alarm Indication Signal (AIS — off or on)
INTF:N64_2M:TXALARM:AIS [OFF|ON]	:Enable (on) or disable (off) AIS transmission over the entire frame
INTF:N64_2M:TXALARM:MFAS?	:Request the current status of the MFAS distant alarm (off or on)

Table 3-6
2.048M/Nx64 Interface Module Remote Control Commands (Continued)

Remote Command:	Activity:
INTF:N64_2M:TXALARM:MFAS [OFF|ON]	:Enable (on) or disable (off) MFAS distant alarm transmission
INTF:N64_2M:TXALARM:T16AIS?	:Request the current status of the TS-16 AIS (off or on)
INTF:N64_2M:TXALARM:T16AIS [OFF|ON]	:Enable (on) or disable (off) TS-16 AIS transmission
INTF:N64_2M:FRWORD:NFAS?	:Request the current Not Frame Alignment Signal (NFAS) word
INTF:N64_2M:FRWORD:NFAS ("eight-bit string")	:Set the NFAS word
INTF:N64_2M:FRWORD:MFAS?	:Request the current Multiframe Alignment Signal (MFAS) word
INTF:N64_2M:FRWORD:MFAS ("eight-bit string")	:Set the MFAS word

* This command is not available for the FIREBERD 4000 mainframe.

3.13 TESTING WITH THE 2.048M/NX64K INTERFACE

The following applications are intended to provide examples of how the 2.048M/Nx64K Data Interface may be used. In the following examples, certain criteria are specified that may not be applicable to all test environments (e.g., framed data, multiframing, and operation mode). Set the FIREBERD and interface parameters as required for your particular test environment. An out-of-service example and in-service are provided. Refer to Figures 3-7 and 3-8 for typical out-of-service and in-service equipment connections.

3.13.1 Out-of-Service Testing

The mainframe and interface settings, listed in Table 3-7, are provided as an example and not intended to define all test environments. Refer to the interface menus found earlier in this section for the FIREBERD 6000 and FIREBERD 4000 menus. Refer to Figure 3-7 for a typical equipment connection.

STEP	ACTIVITY
1.	Configure the FIREBERD mainframe and 2.048M/Nx64k Interface, as indicated in Table 3-7.

Table 3-7
FIREBERD Mainframe and 2.048M/Nx64K Interface Configuration

Switch/ Selection	FIREBERD 6000	FIREBERD 4000
POWER	ON	ON
SELF LOOP	OFF	OFF
DATA PATTERN	2^{15}-1 ———	——— 2^15-1
GEN CLK GENERATOR CLOCK	SYNTH ———	——— SYNTH
INTF SETUP INTERFACE	2M/n64 ———	——— 2M/n64
ANALYSIS MODE	CONTINUOUS	N/A
PRINTER	OFF	OFF
DISPLAY HOLD	OFF	OFF
Switch/ Selection	**INTERFACE 6000**	**INTERFACE 4000**
Operating Mode	Nx64k	Nx64k
Framing	CONFIG:FRAMED	FRAMING:FRAMED
CRC4/TS16	ON	ON
Result	STD	———
Input	TERM	TERM
LBO	0dB	0dB
Intf Clock	RCVR	RCVR
Timeslots	as required	as required
ERRINS	as required	as required

NOTE: ——— indicates that this selection is not available for the mainframe being used.

Depending on the test to be performed, additional mainframe settings (e.g., DATA/PATTERN, AUXILIARY selections, and RESULTS) may be set accordingly.

STEP	ACTIVITY
2.	Connect the 2Mbps IN jack, located on the NTU (Network Termination Unit), to the TX (Transmit) jack, located on the 2.048M/Nx64K Interface (refer to Figure 3-7). Connect the OUT jack, located on the NTU to the RX (Receiver) jack, located on the 2.048M/Nx64K Interface.
3.	Press the RESTART switch on the FIREBERD front panel to reset all results to their zero value and begin the test.
4.	Verify that the LEDs next to the following labels are illuminated: **6000** **4000** SYNC PATTERN SYNC FRM SYNC FRAME SYNC
5.	Use the ANALYSIS RESULTS rocker switches (CATEGORY and RESULT SELECT) to view desired results values.

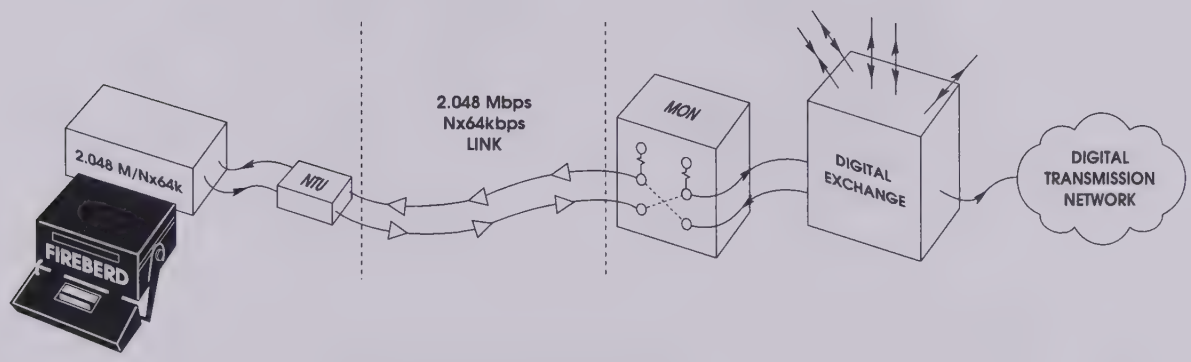

Figure 3-7
Out-of-Service 2.048M/Nx64K Data Interface Equipment Connections

3.13.2 In-Service Live Data Monitoring

The mainframe and interface settings, listed in Table 3-8, are provided as an example and not intended to define all test environments. Refer to the interface menus found earlier in this section for the FIREBERD 6000 and FIREBERD 4000 menus.

STEP	ACTIVITY
1.	Configure the FIREBERD mainframe and 2.048M/Nx64K Interface, as indicated in Table 3-8 and connect the equipment as illustrated in Figure 3-8.

Table 3-8
FIREBERD Mainframe and 2.048M/Nx64K Interface Configuration

Switch/ Selection	FIREBERD 6000	FIREBERD 4000
POWER	ON	ON
SELF LOOP	OFF	OFF
DATA PATTERN	2^{15}-1 — — —	— — — 2^15-1
GEN CLK GENERATOR CLOCK	SYNTH — — —	— — — SYNTH
INTF SETUP INTERFACE	2M/n64 — — —	— — — 2M/n64
ANALYSIS MODE	CONTINUOUS	N/A
PRINTER	OFF	OFF
DISPLAY HOLD	OFF	OFF
Switch/ Selection	**INTERFACE 6000**	**INTERFACE 4000**
Operating Mode	Nx64k Nx64k	
Framing	CONFIG:FRAMED	FRAMING:FRAMED
CRC4/TS16	ON	ON
Result	LIVE	— — —
Input	MON	MON
LBO	N/A	N/A
Intf Clock	N/A	N/A
Timeslots	as required	as required
ERRINS	OFF	OFF

NOTE: — — — indicates that this selection is not available for the mainframe being used.

Depending on the test to be performed, additional mainframe settings (e.g., DATA/PATTERN, AUXILIARY selections, and RESULTS) may be set accordingly.

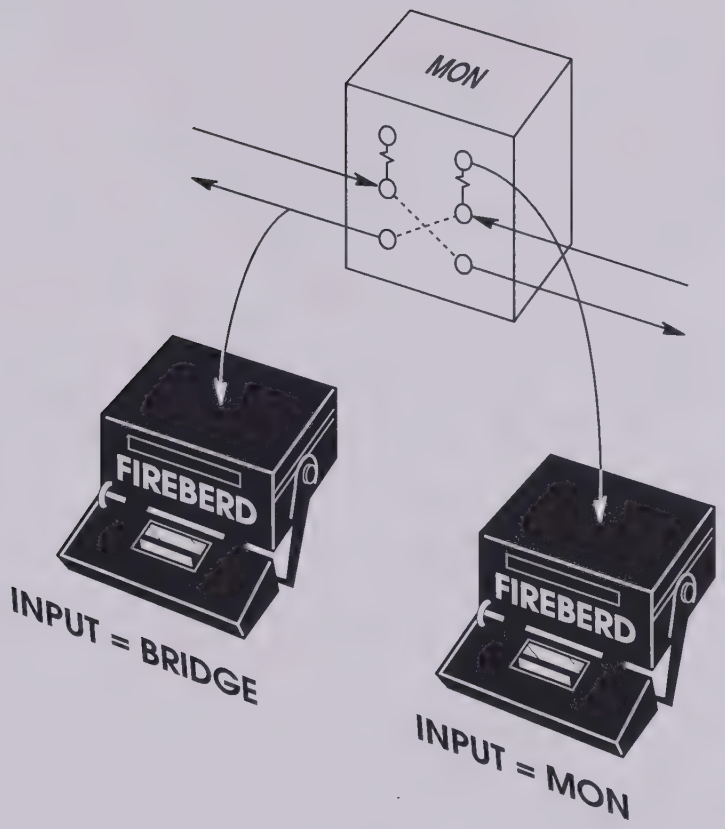

Figure 3-8
In-Service 2.048M/Nx64K Data Interface Equipment Connections

STEP	ACTIVITY
2.	Connect the 2Mbps signal to the TX (Transmit) jack, located on the 2.048M/Nx64K Interface (refer to Figure 3-8). Connect the RX (Receiver) jack, located on the 2.048M/Nx64K Interface to the circuit under test.
3.	Select MON if monitoring at a 2 Mbps resistively isolated monitor point, or select BRDG if the circuit under test is already terminated and not isolated.
4.	Press the RESTART switch on the FIREBERD front panel to reset all results to their zero value and begin the test.
5.	Use the ANALYSIS RESULTS rocker switches (CATEGORY and RESULT SELECT) to view desired results values.

SECTION 4
INTERFACE SPECIFICATIONS

4.1 INTRODUCTION

This section contains the 2.048M/Nx64K Data Interface specifications. This information is contained in Table 4-1.

Table 4-1
2.048M/Nx64K Interface Specifications

Item	Specification
Operating Rate:	2048000 bps
Line Coding:	AMI or HDB3
Connectors:	120Ω balanced, 4mm banana 75Ω unbalanced, BNC
Framing:	Unframed, Framed, TS16 Multiframed (CAS), or CRC4 Multiframed
Error Insertion:	Logic, Code, or L+Code - Single or Rate (1E-9 to 9E-3 for FIREBERD 6000) (1E-6 only for FIREBERD 4000) FAS Word - 1, 2, 3, or 4 consecutive
Transmitter Output:	120Ω level (0 dB) 3.0V ±5% 75Ω level (0 dB) 2.37V ±5%
Transmitter Mask:	Per CCITT G.703
Transmitter LBO Levels:	0 dB, -6 dB, or -12 dB of cable loss or -30 dB resistive
Receiver Input:	Term: +6 to -30 dB (cable attenuation) Bridge: +6 to -30 dB (cable attenuation) Monitor: -10 to -33 dB (resistive loss)
Receive Jitter Tolerance:	Per CCITT G.823 mask
Level Measurements:	Range: + 6 dB to -35 dB Resolution: ±0.1 dB Accuracy: +6 dB to -20 dB: ±1.0 dB Below -20 dB: ±2.0 dB
Jitter Extraction Input Signal Levels:	Term: +6 dB to -6 dB Bridge: +6 dB to -6 dB Monitor: -10 dB to -33 dB (resistive loss)
Reference Input Connector:	75Ω BNC
Reference Input Impedance:	75Ω
Reference Input Level:	0 dB to -33 dB (resistive loss)
Handset Connector:	RJ8
Handset Port Companding:	A-Law or μ-Law (switch selectable)

SECTION 5
MAINTENANCE AND SERVICE

5.1 INTRODUCTION

This section contains information on maintenance and service procedures for the 2.048M/Nx64K Data Interface. TTC's warranty policy and repair procedures are also described in this section.

5.2 MAINTENANCE

5.2.1 In Case of Difficulty

If the interface fails to operate and no front panel indicators illuminate, check the following:

- AC line power and AC power supply of the FIREBERD and/or ISU.
- AC fuses and fuse rating.

If some of the indicators illuminate but the unit fails to operate, verify that the interface is properly inserted in the mainframe(turn power off before removing or inserting the interface). Check the interface and/or mainframe cabling and connections to verify proper connections. Substituting a known good interface is recommended, if one is available.

If problems still persist, follow the self-test procedures described in the *FIREBERD Reference Manual* to aid in localizing the problem. If the unit continues to be inoperative, refer to the following paragraphs for servicing information or call TTC's Customer Service Department for applications assistance.

5.3 SERVICE

5.3.1 Warranty Policy

All equipment manufactured by Telecommunications Techniques Corporation is warranted against defects in material and workmanship. This warranty applies only to the original purchaser and is non-transferable, unless express written authorization is granted by TTC for a warranty transfer.

Liability under this warranty extends only to the replacement value of the equipment. The warranty is void if:

1) The equipment has been altered or repaired without specific authorization from TTC.

2) The equipment is installed or operated in a manner other than those contained in TTC literature and operating manuals.

No other warranty is expressed or implied. TTC is not liable for consequential damages.

5.3.2 In-Warranty Service

Equipment that is in warranty must be returned to the factory with shipping prepaid. The equipment should be packed and shipped in accordance with the instructions in paragraph 5.3.4 of this manual. Before returning any equipment, the customer must obtain a RA (Return Authorization) number RA numbers are obtained by contacting the TTC Repair Department. The RA number should then appear on all paperwork and be clearly marked on the shipping container.

After the equipment is repaired by TTC, it will be tested to applicable specifications; aligned and retested, if necessary, and returned to the customer with shipping prepaid. A brief description of work performed and materials used will be provided on the equipment repair form that is furnished with the returned equipment.

5.3.3 Out-of-Warranty Service

The procedure for repairing out-of-service equipment is the same as used for in-warranty equipment. However, there is a minimum charge applied to each request for out-of-warranty service. This minimum charge guarantees the customer an estimate of the repair costs and is used as credit against actual materials and labor costs, should the equipment be repaired. Contact TTC's Repair Department for specific information on the minimum out-of-service repair charge.

The customer will be billed for parts, plus standard labor rates in effect at the time of repair. The customer will also be required to furnish a purchase order number before repair work is started. A hard copy of the purchase order must be received by TTC before the repaired equipment is shipped to the customer. A description of the labor and materials used is provided in the equipment repair report.

Once an out-of-warranty repair is made, the repaired part or component is warranted for 90 days. This warranty applies only to the part or component that was repaired. Other parts or components are not covered under this 90-day warranty.

5.3.4 Equipment Return Instructions

The customer should attach a tag on all equipment that is returned to TTC for repair. This tag should include the following information:

1) Customer's name and address.

2) A list of all equipment being returned and the corresponding serial number(s), if applicable.

3) A detailed description of the problem or service requested.

4) The name and telephone number of the person to contact regarding questions about the requested repair.

5) The RA number, issued by TTC's Repair Department.

If possible, the customer should return the equipment using the original shipping container and material; providing that it is in good condition. If the original container is not available, the unit should be carefully packed to ensure that it will not be damaged in transit. TTC is not liable for any damage incurred during shipment. The customer should clearly mark the TTC-issued RA number on the outside of the shipping container and ship it prepaid and insured to TTC.

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